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WENE (G. P.) & BLANCHARD (R. A.). **Insecticide Dust for Control of the Corn Earworm.**—*J. econ. Ent.* **43** no. 1 pp. 1–4, 4 refs. Menasha, Wis., 1950.

Heliothis armigera, Hb., limits the production of a good grade of sweet maize in the Lower Rio Grande Valley of Texas and also severely injures the whorls of young maize planted in autumn, and since most of the insect control work in this area is done by means of dusting from aeroplanes, comparative experiments were carried out during the spring and autumn of 1947 and 1948 on the value of dusts for its control. Hand equipment was used. In the first three tests reported, the dusts were applied to protect the ears. The results are given as average numbers of larvae per ear and (in brackets) percentages of ears free from infestation. For single applications of 5 per cent. DDT in talc or 5 per cent. DDD (dichlordiphenyldichlorethane) in Cherokee clay, made just after the majority of the silks had been fertilised, these figures were 1·2 (50) and 1·8 (38), as compared with 2·6 (10) for no treatment. When three applications were made, at the time the tassels first showed, when about 90 per cent. of the plants were showing silks, and again five days later, they were 0·3 (40) for 5 per cent. DDT in talc, 0·6 (30) for 5 per cent. DDD in clay, 1·2 (7) for 5 per cent. toxaphene in talc, 0·4 (33) and 0·3 (46) for 5 per cent. DDT with 0·5 and 1 per cent. γ BHC (benzene hexachloride), and 0·9 (23) and 0·8 (13) for 5 per cent. DDD with 0·5 or 1 per cent. γ BHC in clay, respectively, as compared with 1·7 (0) for no treatment. The results were no better when three or four applications of 5 per cent. DDT or methoxy-DDT (methoxychlor) in talc, 5 per cent. DDD or chlordan in clay, 2·5 per cent. aldrin [1,2,3,4,10, 10-hexachlor - 1,4,4a,5,8,8a - hexahydro - 1,4,5,8 - diendomethanonaphthalene] in clay or 1 per cent. oil-impregnated DDT in clay were made at intervals of three days, beginning when about 15 per cent. of the plants showed silks, and it is concluded that none of the treatments tested would give commercial control.

In a test in which dusts were applied to the whorls four times at weekly intervals beginning when the maize was about 4 ins. high, the percentages of plants that contained larvae a week after the last treatment and (in brackets) of those injured were 47 (30) for 5 per cent. DDT, 14 (5) for 1 per cent. parathion, and 49 (35) for 10 per cent. toxaphene, all in talc, and 65 (59) for 0·1 per cent. pyrethrins with 0·5 per cent. DDT, 62 (45) for 5 per cent. chlordan and 65 (56) for 5 per cent. DDD, all in clay, as compared with 95 (79) on untreated plants. Single applications of sprays containing 4 lb. 10 per cent. wettable DDT, 4 lb. 50 per cent. wettable chlordan, 3 lb. 15 per cent. wettable parathion or 2 U.S. quarts of an emulsion of 25 per cent. DDT in a petroleum-hydrocarbon solvent per 100 U.S. gals. water when the plants were 3 ft. tall resulted in 7, 2, 0 and 0 per cent. whorls with living larvae after 13 days, and two applications of 20 lb. 5 per cent. DDT dust per acre at the same time and a week later and no treatment resulted in 33 and 45, respectively. As the parathion dust was used when the maximum day temperature was 100°F. or more, it may have acted as a fumigant in the whorl ; this material is extremely toxic to man and should not be used until more is known about the ways of handling it safely. The other dusts were of little value, but the sprays gave good control, DDT, chlordan and parathion being considered equally effective.

BECK (S. D.) & STAUFFER (J. F.). **An aseptic Method for rearing European Corn Borer Larvae.**—*J. econ. Ent.* **43** no. 1 pp. 4–6, 1 fig., 2 refs. Menasha, Wis., 1950.

The authors give the composition of a stable purified diet containing carbohydrate, protein, lipids, minerals, vitamins and a leaf factor in an inert (agar-cellulose) carrier that was used for rearing larvae of *Pyrausta nubilalis*, Hb., aseptically. He describes the method used, which is simple and can be

(1306) Wt. P2701/3853 1/51 S.E.R. Ltd. Gp. 432. [A] A

used for individual larvae or large numbers. Eggs obtained by confining adults in wire cages covered with waxed paper are removed from the paper when in the early "black-head" stage, and separated by immersion for an hour at 35°C. [95°F.] in a fresh solution of 2 per cent. commercial trypsin (1 : 300) buffered at pH8 with 0·05 M phosphate buffer. They are washed in 5–6 changes of distilled water to remove the trypsin, immersed in 40 per cent. ethyl alcohol for one minute and then surface sterilised in a solution containing 2 per cent. sodium hydroxide and 2 per cent. formaldehyde for ten minutes, rinsed in 70 per cent. ethyl alcohol and dropped on to the agar medium. When the larvae were reared in individual vials, egg and larval mortality was usually less than 30 per cent., the larvae matured in 17–25 days at 30°C. [86°F.], pupation and adult emergence were normal, and fertile eggs were obtained from the moths. The larvae were readily observed during development as they tended to feed on the surfaces of the medium in contact with the wall or bottom of the container. Less manipulation and space were required when the larvae were reared in batches in Erlenmeyer flasks, but mortality was higher because they were somewhat cannibalistic, and development could not be followed in detail.

This technique was developed only for *P. nubilalis*, but it could probably be used for other leaf-feeding insects with little alteration.

WEAVER (C. R.). **Improvement in Hay Yields resulting from Control of the Meadow Spittlebug.**—*J. econ. Ent.* **43** no. 1 pp. 7–11, 4 refs. Menasha, Wis., 1950.

A decline in the yields of lucerne and red clover in Ohio during the last ten years has coincided with an increase in the abundance of *Philaenus leucophthalmus*, L., though the effects of infestation by this Cercopid were often overlooked because the masses of froth produced by the nymphs were no longer present by the time of the first cutting. The development of BHC (benzene hexachloride) and other effective insecticides has made it possible to evaluate the damage caused by both nymphs and adults [*cf. R.A.E.*, A **37** 475 ; **38** 283, etc.] and tests were accordingly made in 1949.

The first nymphs were found on 14th April, masses of froth containing large numbers of nymphs were present in the crowns of red clover a week later, and hatching was probably completed by 1st May, indicating that control measures have generally been applied too late rather than too early. Early applications eliminate the Cercopid at an early stage and reduce the residue problem. Applications of BHC sprays on 29th April or 10th May at the rate of 2 lb. γ isomer per acre gave complete control on clover and lucerne by 13th May and increased the yield of hay by 56·7 and 39·1 per cent., respectively, and applications of 2 lb. aldrin [1,2,3,4,10,10-hexachlor-1,4,4a,5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene], parathion or ethyl paranitrophenylthionobenzene phosphonate per acre in sprays on 10th May gave 92, 26 and 16·5 per cent. reduction of infested stems within the same period and increased the yield by 42·6, 9 and 32·6 per cent. ; later counts might have shown better control by the last compound. Yield differences were affected to some extent by control of other insects. A second cutting of the treated areas did not reveal any differences in the plots, and no other test gave any indication that the treatment of the first cutting had any effect on the second. A preliminary study of the effect of infestation on the nutritive value of the hay showed that BHC treatment on either date increased the carotenoid and protein contents of both lucerne and red clover, and improved the aspect, texture and odour of the hay.

Applications of 0·36 per cent. γ BHC dust to mixed clover and lucerne on 6th, 14th or 20th May reduced the numbers of infested stems on 23rd May by

43·4, 78·6 and 98·3 per cent. and increased the yield of hay by 39·9, 39·3 and 22·5 per cent., and 0·75 per cent. rotenone dust applied on 14th May reduced infestation by 15·1 per cent. and increased yield by 32·5 per cent. It was apparent that early treatment was necessary for the best results.

Treatment of a large area of mixed red clover and lucerne on 10th May with 2 oz. γ BHC per acre in a spray prepared from a wettable powder containing 50 per cent. lindane [at least 99 per cent. γ BHC] and applied at a pressure of 250 lb. per sq. in., reduced the percentage of infested stems from 87·8 to 28·8 on 18th May and increased the yield by 44 per cent. Similar large-scale treatment with 3·2 oz. γ isomer per acre in a spray prepared from wettable technical BHC reduced the percentage of infested stems from 95 to 3·4. In tests with a low-pressure sprayer [*cf.* **38** 196] on a mixed field, applications of 2 oz. γ BHC per acre from 25 per cent. lindane on 7th May gave 35·4 per cent. reduction of infested stems by 16th May when made in 40 U.S. gals. water per acre at a pressure of 50 lb. and 60·3 per cent. when made in 20 U.S. gals at 30 lb. ; the corresponding yields were 60 and 58 lb. per acre, as compared with 49 lb. for no treatment. Clogging of nozzles caused considerable difficulty and delivery was uneven. In a limited test on poor clover in which a fleabane (*Erigeron annuus*) was abundant and heavily infested, an emulsion concentrate containing 0·9 lb. γ BHC per U.S. gal. in a xylene base, applied at 3·2 oz. γ isomer per acre, reduced the percentage of infested stems by 75·5, 85·4 and 84·5 when applied in 18, 36 and 10 U.S. gals. spray per acre at pressures of 100, 100 and 30 lb. per sq. in., with no injury to the plants. The fleabane in the sprayed area grew twice as tall and flowered much more profusely than that in the unsprayed one.

Wilcox (J.) & Howland (A. F.). **Effect of Addition of Sulfur to DDT Dusts for Onion Thrips Control.**—*J. econ. Ent.* **43** no. 1 pp. 11–13, 4 refs. Menasha, Wis., 1950.

Field tests on the value of adding sulphur to the DDT dusts used for the control of *Thrips tabaci*, Lind., on onion in southern California [*cf. R.A.E.*, A **38** 13] were carried out in 1946 and 1948. Analysis of variance of the results in each year showed that any apparent effect of sulphur on the insecticidal value of DDT was within the limits of experimental error, and comparisons were therefore made between the averages of the results for dusts containing each percentage of sulphur and each percentage of DDT. In 1946, when dusts containing 2·5, 5 or 10 per cent. DDT, each with 0, 25, 50 or (in fused dusts) 85 per cent. sulphur were applied at 30 lb. per acre three times at approximately weekly intervals from 3rd May, the only significant difference found was that 2·5 per cent. DDT was inferior to 5 or 10 per cent. DDT against both nymphs and adults.

In 1948, 5 or 10 per cent. DDT in dusts containing 0, 25, 50 or 75 per cent. sulphur were applied three times at intervals of two weeks from 4th March, when the plants were eight inches high and infested with an average of 32 nymphs and 4 adults. Counts were made one and two weeks after each application, and the results of the first two applications indicated that mixtures containing 25 per cent. sulphur were significantly inferior to those containing 0 or 75 per cent. against the adults and that 10 per cent. DDT was more effective than 5 per cent., but after the last application, DDT mixtures containing 50 per cent. sulphur were significantly more effective against both nymphs and adults than those containing 0 or 25 per cent. Mixtures containing 75 per cent. sulphur were more effective than those containing 0 or 25 per cent. against the nymphs and 10 per cent. DDT was significantly more effective than 5 per cent. against both nymphs and adults. The increased control given by the addition of 50 per cent. or more sulphur to the DDT dusts appeared to be

related to temperature, since significant differences were obtained during the last two weeks of the season in 1948, when the mean temperature was 66·8°F., but not during the previous four weeks when it was 60·2° or in 1946 when it was 61·1°. The increased control obtained with the sulphur mixtures was reflected in moderate but not statistically significant increases in crop yield in 1948.

CROWELL (H. H.) & MORRISON (H. E.). **The Phytotoxicity to Cucurbits of some new Insecticides.**—*J. econ. Ent.* **43** no. 1 pp. 14–16, 3 refs. Menasha, Wis., 1950.

Small-scale tests were made in 1947–49 on the phytotoxic effects of a number of insecticides on common varieties of cucurbits in connection with studies on the control of *Anasa tristis*, Deg., and *Diabrotica undecimpunctata*, Mannh., in eastern and western Oregon, respectively. The dusts tested contained 3 and 5 per cent. DDT, 4 per cent. DDT fused with 80 per cent. sulphur, 3 per cent. DDD (dichlordiphenyldichlorethane), 5 per cent. methoxy-DDT (methoxychlor), 5 and 10 per cent. toxaphene, BHC (benzene hexachloride) to give 1 per cent. γ isomer, 1·5 per cent. lindane [at least 99 per cent. γ BHC], BHC to give 0·5 per cent. γ isomer with 2·5 per cent. chlordan, 5 per cent. chlordan, 20 per cent. sabadilla, 5 per cent. sabadilla with 2·5 per cent. DDT or toxaphene, 0·5 and 1 per cent. parathion, 1 per cent. aldrin [1,2,3,4,10,10-hexachlor-1,4,4a, 5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene], 1 per cent. dieldrin [1,2,3,4,10,10 - hexachlor - 6,7 - epoxy - 1,4,4a,5,6,7,8,8a - octahydro - 1,4,5,8 - diendomethanonaphthalene] and a mixture of 0·5 per cent. piperonyl cyclonene, 0·05 per cent. pyrethrins, 0·25 per cent. rotenone, 0·5 per cent. cubé extractives and 25 per cent. sulphur.

With a few exceptions, the insecticides were not consistent in producing injury on any one variety of cucurbits, but the only dust that caused none was the 20 per cent. sabadilla, and it appeared that all the chlorinated hydrocarbons can injure cucurbits in general under certain conditions, and that the inclusion of sulphur in the insecticidal dusts for mite or fungus control can produce serious injury. In many cases, injury was associated with natural or artificial moist conditions. It is concluded that methoxy-DDT is probably safe enough for use against *Diabrotica* in wester Oregon if applications are not made during wet periods ; and that the squash varieties of the species *Cucurbita maxima* seem to be more tolerant of the organic insecticides than others. Umatilla Marblehead is the most tolerant to toxaphene of these varieties, and though it can be injured by it under certain conditions, it has not so far been affected by the use of toxaphene against *A. tristis* in the dry conditions of eastern Oregon.

TURNER (N.) & BEARD (R. L.). **Effect of Stage of Growth of Field Corn Inbreds on Oviposition and Survival of the European Corn Borer.**—*J. econ. Ent.* **43** no. 1 pp. 17–22, 1 fig., 11 refs. Menasha, Wis., 1950.

The following is based on the authors' summary. Observations in the literature suggested that the resistance of maize to the European corn borer [*Pyrausta nubilalis*, Hb.] was an expression of the occurrence of an unfavourable stage of growth at the time of infestation and that the transfer of resistant varieties to another environment might cause loss of resistance if a susceptible stage of growth coincided with the infestation. To test this, two resistant inbreds from the Middle West, Oh 43 and Oh 51A, two susceptible inbreds, M14 and Wf9, and two Connecticut inbreds, C103, characterised by low breakage and high sugar content, and C102, showing high breakage, were planted in Connecticut on 12th April, 11th May and 31st May.

Only the first planting was substantially infested by larvae of the first generation. Egg deposition seemed to be associated with leaf area rather than height of plants, and the survival of larvae indicated no change in the pattern of resistance established in the Middle West. Second-generation eggs were deposited more in relation to stage of growth than to height of plants and survival of larvae increased with the maturity of the plant. The pattern of resistance and susceptibility established in the Middle West was altered completely, the relative resistance and susceptibility of the inbreds being apparently determined by the stage of growth of the plants when the eggs were deposited.

These results indicate the necessity of developing different resistant varieties for areas with different ecological conditions. Data were insufficient to measure the resistance of inbred C103 to breakage.

FRONK (W. D.). **Cultural and Biological Control of the Southern Corn Rootworm in Peanuts.**—*J. econ. Ent.* **43** no. 1 pp. 22–24, 1 ref. Menasha, Wis., 1950.

In studies on the cultural control of *Diabrotica undecimpunctata howardi*, Barber (*D. duodecimpunctata*, auct.) made in 1947 at Holland, Virginia, where the larvae injure groundnuts severely on heavy, poorly drained soils [*cf. R.A.E.*, A **36** 337], no reduction in infestation was obtained by changing planting dates or the spacing of the plants. Preliminary tests showed that the small, bunch-type groundnuts were more resistant to attack than the larger runner-type, but the Holland Runner variety, which has medium-sized pods and is much grown in the Virginia-Carolina area, showed some resistance and is so well adapted to the area that it appeared to be the most promising to grow where severe infestation is expected.

Surveys of natural enemies showed that the adults were parasitised by the Tachinid, *Celatoria diabroticae*, Shim., and four nematodes (*Howardula benigna*, Cobb, *Diplogaster* spp. and *Neoaplectana* sp., which transmits a bacterial disease to them) and the larvae were attacked by predacious Coleoptera, including species of *Xantholinus*, *Anisodactylus*, *Agonum*, *Amara* and *Pterostichus* (*Poecilus*), but only *C. diabroticae* and *H. benigna* were sufficiently numerous to be of any importance.

SWANK (G. R.) & LATTA (R.). **Vacuum Fumigation with Methyl Bromide to kill Larvae of White-fringed Beetles.**—*J. econ. Ent.* **43** no. 1 pp. 25–29, 2 figs. Menasha, Wis., 1950.

The results are given of tests carried out since 1940 in Louisiana, Mississippi, North Carolina and Georgia on the destruction of larvae of *Graphognathus* spp. (white-fringed beetles) in soil balls by vacuum fumigation with methyl bromide. Artificially infested balls were generally used ; most were dug from field soil and wrapped in burlap, others were moulded by packing a pot with loose soil containing larvae, and those larger than 18 ins. in diameter were moulded in hardware cloth. Artificially infested balls were allowed to stand for five days before fumigation, and fumigated balls for at least 24 hours to allow fumigation to have its full effect. Pressure in the fumigation chamber was reduced to approximately 2 ins. mercury before liquid methyl bromide was introduced, and a vacuum of at least 24·5 ins. mercury was maintained throughout the treatments. Exposure was for 90 minutes, and an electric fan was operated in the chamber while the methy bromide was being injected and for the first 15 minutes of exposure to insure thorough distribution of the gas.

There was a tendency for a given dosage to produce slightly lower mortality in small soil balls than in larger ones, probably owing to some post-fumigation effect in the latter. Larval mortality was not affected by differences in soil

type or by normal variations in soil moisture, though it was reduced when the soil was saturated or dry enough to cause wilting of plants. Six strains of *Graphognathus* showed no differences in susceptibility. The methyl bromide was more effective at higher temperatures and the increase in effectiveness was consistent for each unit rise in temperature between 40 and 80°F. As the dosages required to kill *Graphognathus* larvae in soil balls were near the limit of plant tolerance, schedules of the lowest dosages that would give adequate control were developed. Dosages ranging from 2 lb. per 1,000 cu. ft. at 80°F. to 6 lb. at 40°, increasing by ½ lb. for every drop of 5° in temperature, were considered satisfactory for plants from areas known to be infested and dosages varying from 2 lb. at 80° to 2·5 lb. at 65° and from 3 lb. at 60° to 5 lb. at 40° for plants exposed to infestation or for precautionary purposes.

Most broad-leaved evergreens tolerated these schedules, but coniferous evergreens were usually slightly or severely injured.

SUN (Yun-Pei). **Toxicity Index—an improved Method of comparing the relative Toxicity of Insecticides.**—*J. econ. Ent.* **43** no. 1 pp. 45–53, 12 refs. Menasha, Wis., 1950.

The author considers that the toxicity of an insecticide is best expressed by comparing it with some standard insecticide against a given species of insect and calculating a toxicity index according to the formula 100 S/T, where S and T are the median lethal doses (expressed as median lethal concentrations in this paper) of the standard and the test insecticide, respectively. The index will vary with species of insect, method of application and temperature, though the differences can be minimised by the use of a standard that is similar in composition to the test insecticide, but experiments in which adults of *Musca domestica*, L., were sprayed in a wind-tunnel with organic materials of similar composition showed that it was largely independent of volume of spray, wind velocity in the spray tunnel, fineness of spray, spraying pressure, the criterion of death, the length of time between spraying and mortality counts, the age and size of the flies, and allowance for mortality of untreated flies. The technique of the tests and the order of toxicity to the flies of the insecticides used are noticed elsewhere [*cf. R.A.E.*, B **38** 186]. It is shown that the toxicity index of one insecticide with respect to a chosen standard can be transformed by a simple calculation to an index based on another standard with very little error, and it is suggested that strains of a species of insect can be characterised by their toxicity indices for a number of insecticides.

GARMAN (P.). **Parathion resistant Red Spiders.**—*J. econ. Ent.* **43** no. 1 pp. 53–56, 1 ref. Menasha, Wis., 1950.

It was observed in the winter of 1948–49 that colonies of red spiders [*Tetranychus*] in certain rose houses in Connecticut were not being killed by treatment with parathion aerosols. Samples were therefore taken to the laboratory, established on beans, and compared on 11th January and later with strains known to be non-resistant. The resistant stocks showed no resistance to aerosols of tetraethyl pyrophosphate, parachlorphenoxymethane, di(parachlorphenyl)methyl carbinol or an alkyl sulphite and had gradually lost their resistance to parathion by 4th May. Colonies from Long Island houses also showed resistant trends. Additional mites collected from the Connecticut rose houses in June appeared to have retained their resistance, and it was concluded that the loss of resistance in the laboratory was possibly due to the mites having been maintained on beans for so long. Aerosols of hexaethyl tetraphosphate were substituted for parathion in the Connecticut houses and were in use up to

the time of writing, but since resistance to this material also appeared to be slowly developing in houses in which it had been used longest, several new chemicals were tested in aerosols. Of these, tetraethyl dithiopyrophosphate appeared to be quite effective, practically eliminating a very heavy infestation after five applications at intervals of 3–4 days, and parachlorphenyl para-chlorbenzene sulphonate kept populations at a low level when used once a fortnight. A strain resistant to one organic phosphate is therefore not necessarily resistant to another. Evidently some food element may be important, and the few mites and eggs that always survive the most intensive treatments may give rise to resistant strains after treatment with one chemical for a year or two.

Spectrographic analysis of mites from beans showed that they were taking up quantities of molybdenum much in excess of what would be expected in foliage. Molybdenum seems to be connected in some way with nitrogen assimilation by beans. Large mite populations developed on plants grown in sand cultures treated with ammonium molybdate to the point of stunting the plants. Mites from these plants showed little resistance to parathion. More mites matured on beans receiving equal small quantities of selenium and molybdenum than on those receiving selenium only.

HETRICK (L. A.). **The Toxicity of some organic Insecticides to the Eastern Subterranean Termite.**—*J. econ. Ent.* **43** no. 1 pp. 57–59, 4 refs. Menasha, Wis., 1950.

The results are given of soil tests with organic insecticides against *Reticulitermes flavipes*, Koll., begun in Ohio in 1946 and continued in Florida in 1947. Each test unit was a large jar half filled with moist sandy soil ; a known proportion of insecticide was thoroughly mixed with the soil, and ten large worker termites were liberated on a folded wet paper towel placed on the soil surface. Observations were made every 24 hours for five days and the soil was remoistened and reinfested once a month ; no tests were made when the average temperature was likely to be 60°F. or lower. DDT and pentachlorphenol at 1 : 200, DDD (dichlordiphenyldichlorethane) and methoxy-DDT (methoxy-chlor) at 1 : 1,000, toxaphene at 1 : 10,000, chlordan at 1 : 20,000 and γ BHC (benzene hexachloride) at 1 : 50,000 were still effective after three years and sodium pentachlorphenate at 1 : 1,000 and parathion at 1 : 5,000 after two, the longest period for which they were tested ; γ BHC at 1 : 100,000 was still toxic after three years though weakening in effect, but pentachlorphenol at 1 : 2,000 sodium pentachlorphenate at 1 : 5,000, toxaphene at 1 : 20,000, parathion at 1 : 10,000 and paradichlorbenzene at 1 : 100 all lost their toxicity within 1–7 months. The insecticides tested were not noticeably repellent to the termites. Toxicity was usually due to contact action, only the most concentrated mixtures of parathion, paradichlorbenzene, pentachlorphenol and sodium pentachlorphenate showing apparent fumigant effect. DDT and its analogues acted slowly at first but increased in speed of action after the first year. Chlordan at 1 : 200–1 : 2,000 and γ BHC at 1 : 1,000–1 : 5,000 consistently gave complete mortality within 24–48 hours, and no objectionable odour was present in soil treated with BHC. Pentachlorphenol and sodium pentachlorphenate showed marked loss of toxicity during the testing period, but their fungicidal qualities contribute to their value in termite control work. Infested buildings that were treated with toxaphene had some recurrence of infestation that apparently indicated inferior performance of this compound under practical conditions. Parathion appeared to be less toxic to subterranean termites than BHC, chlordan or toxaphene. Paradichlorbenzene was an extremely toxic fumigant, but its volatility caused its early failure in tests in which it was used as a soil poison.

Linsley (E. G.), MacSwain (J. W.) & Smith (R. F.). **Comparative Susceptibility of Wild Bees and Honey Bees to DDT.**—*J. econ. Ent.* **43** no. 1 pp. 59–62, 11 refs. Menasha, Wis., 1950.

The authors describe preliminary experiments carried out in California in an attempt to determine whether apparent differences in the reactions of wild bees and honey bees to DDT reported in the literature and observed in the field in 1949 reflected differences in susceptibility to the compound. In addition to honey bees, the species tested were *Agapostemon cockerelli*, Cwfd., *Nomia melanderi*, Ckll., *Anthidium edwardsii*, Cress., *Megachile brevis*, Say, and *Melissodes agilis*, Cress., all of which visit lucerne, the last only casually, and 10–20 of each were confined in separate cages with removable sides that permitted the substitution of treated or untreated screens of hardware cloth. When exposed continuously for 24 hours to screens that had been dipped in solutions of 0·5, 2 and 5 per cent. pure DDT in benzene, shaken to remove excess liquid and dried, *Nomia* was less affected than honey bees, and most of the early mortality of *Nomia* was of males. When the bees were exposed for 15 or 45 minutes to screens treated with 0·5 per cent. DDT, mortality was similar for the two species, but when the exposure was for 135 minutes, *Nomia* was again the more resistant. Further tests, in which bees of each species were exposed constantly for 24 hours to screens treated with 0·25 or 0·5 per cent. DDT, showed that each species of wild bee was less rapidly and less severely affected than the honey bee at comparable concentrations. Although the numbers of individuals involved were small, females appeared to be more resistant than males.

Kerr jr. (T. W.). **Insecticides for Control of certain Insects attacking ornamental Trees and Shrubs.**—*J. econ. Ent.* **43** no. 1 pp. 63–65, 2 refs. Menasha, Wis., 1950.

The following is based on the author's summary. During 1949, several insecticides were compared in field tests against four insects attacking ornamental trees and shrubs in Rhode Island. The quantities of insecticides given are per 100 U.S. gals. water ; the chlorinated hydrocarbons were in the form of wettable powders.

DDT was more effective than chlordan against *Phytomyza ilicicola*, Lw. (*ilicis*, auct.) on American holly (*Ilex opaca*). Two applications of 1 lb. DDT., the first when adult emergence had just begun and the second 13 days later, reduced the percentage of leaves injured by the larvae from 83·7 to 6·5. The erratic and unfavourable performance of chlordan may have resulted from the flocculation of the powder at the time of application.

Single applications of 1 or 2 lb. nicotine sulphate or 0·5 or 1 lb. technical BHC (benzene hexachloride) were effective against *Phyllaphis fagi*, L., on purple beech. DDT and chlordan were ineffective at 0·5–1 lb.

Single applications of 2 or 4 oz. lindane [at least 99 per cent. γ BHC] or 0·5 or 1 lb. DDT gave 99–100 per cent. control of *Corythucha arcuata*, Say, on oak. Sprays containing 1 and 2 lb. nicotine sulphate gave 71·3 and 77 per cent. control.

The population of an unidentified species of *Pulvinaria* in its first instar on yew [*Taxus*] was reduced by 99 per cent. or more by a single application of 1–2 lb. nicotine sulphate and by 93 per cent. by 1 lb. DDT ; 0·5 or 1 lb. BHC was ineffective.

McBride (O. C.), Sullivan (W. N.) & Fulton (R. A.). **Treatment of Airplanes to prevent the Transportation of Insects.**—*J. econ. Ent.* **43** no. 1 pp. 66–70, 3 graphs, 6 refs. Menasha, Wis., 1950.

Investigations on the effectiveness of insecticidal deposits and aerosols, alone and in combination, for the control of insects being accidentally

transported in aircraft are described. Numerous species of insects were used, including representatives of the important orders and many agricultural pests when these were available ; among the most resistant were cockroaches (*Periplaneta americana*, L.), *Tribolium confusum*, Duv., *Leptinotarsa decemlineata*, Say, *Epilachna varivestis*, Muls., and grasshoppers, and all these were included in the tests in which aircraft were treated. To test the efficiency of deposits, 17 insecticidal solutions propelled by carbon dioxide were applied to vertical aluminium panels and allowed to dry, and insects were confined on them for one hour. Of the three most promising mixtures, which are given, one of DDT, dichlordifluoromethane, pyrethrum extract (20 per cent. pyrethrins), piperonyl butoxide and methylene chloride (10 : 20 : 5 : 5 : 60) was selected for further testing. Laboratory studies of 24 aerosols were made in a Peet-Grady chamber, and of the three most promising, one of DDT, cyclohexanone, dichlordifluoromethane, piperonyl butoxide, pyrethrum extract (20 per cent. pyrethrins) and lubricating oil (3 : 5 : 84 : 2 : 5 : 1) was selected for further work.

Tests of combined treatments were made in a room and in aeroplanes on the ground and in flight ; the deposit spray was applied to give 75 mg. DDT per sq. ft. and allowed to dry before the aerosol was released, and the test insects were exposed to deposits alone for one hour and to the combined treatments for 10–60 minutes, being introduced just before the release of the aerosols and removed after treatment. All treatments were similar except that 3 per cent. diesel oil (SAE 50) was added to the residual spray when it was applied in the aeroplane while in flight. The floor, walls and ceiling of the room were treated once to give the desired deposit of DDT, and the aerosol was applied five times a week at 35 gm. solution per 1,000 cu. ft. This gave almost complete kill of agricultural insects for 54 days. The aerosol treatment was then suspended, whereupon the percentage mortality declined to 91 after 42 days and 52 after 143 days. The amount of deposit on the floor and walls was shown to increase with each application of aerosol, and about 95 per cent. of the nonvolatile material released was recovered from the horizontal surfaces.

In aeroplanes on the ground, the deposit spray was applied twice at 13 days interval and gave 86 per cent. or more kill of the insects for the five weeks during which it was tested. Deposits on the floor and ceiling were more effective than those on the walls. When this treatment was combined with the use of the aerosol at 20 gm. per 1,000 cu. ft., the mortality over the same period was at least 96 per cent. In aeroplanes in flight, the percentage mortality of the test insects in 96 hours was 100 for a deposit of 75 mg. DDT per sq. ft. and the aerosol at 20 gm. per 1,000 cu. ft. and 99 when the rate of application of the aerosol was reduced to 5 gm. ; the tests were carried out over a week only.

It is concluded that deposits alone do not free aeroplanes of insects, but are useful in concealed and semi-concealed areas to which the aerosols do not easily penetrate.

RINGS (R. W.). **Residual Action of organic Insecticides against Plum Curculio.**—*J. econ. Ent.* **43** no. 1 pp. 70–72, 2 refs. Menasha, Wis., 1950.

The results are given of insectary cage tests in Ohio on the speed of knockdown, lethal action and residual toxicity of deposits of 13 organic insecticides tested against the plum curculio [*Conotrachelus nenuphar*, Hbst.]. Peach terminals were immersed in aqueous suspensions of the various materials on 20th July, thoroughly dried and infested with 20 adults immediately or after 5 or 10 days. The toxicity of deposits weathered out of doors was determined by immersing the terminals without removing them from the trees ; after ten days they were removed and exposed to the weevils.

In tests designed to measure the initial speed of kill of the deposits, the best results were obtained with 25 per cent. parathion, 35 per cent. ethyl orthonitrophenyl thionobenzenephosphonate and 35 per cent. ethyl paranitrophenyl thionobenzenephosphonate, all of which killed half the weevils in approximately two hours at 2 lb. per 100 U.S. gals. water. They also exhibited exceptional residual toxicity, the orthonitrophenyl compound being slightly superior to the other two. Both initial and residual toxicity remained high when the latter two were used at half the strength. Deposits from 1 lb. 40 per cent. tetraethyl pyrophosphate per 100 U.S. gals. gave rapid kills when fresh but lost some of their toxicity within five days and killed only 20 per cent. of the weevils that fed on treated foliage for 102 hours ten days after treatment. Of the chlorinated hydrocarbons, aldrin [1,2,3,4,10,10-hexachlor-1,4,4a,5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene], dieldrin [1,2,3,4,10,10 - hexachlor - 6,7 - epoxy - 1,4,4a,5,6,7,8,8a - octahydro - 1,4,5,8 - diendomethanonaphthalene], chlordan and heptachlor [1 (or 3a), 4,5,6,7,8,8-heptachlor-3a,4,7,-7a-tetrahydro-4,7-endomethanoindene] were more effective than toxaphene or, technical or refined BHC (benzene hexachloride) in initial toxicity, but even though these compounds gave rapid knockdown, their lethal action was relatively slow, and some weevils recovered after they had been apparently knocked down by aldrin. Except for dieldrin, which appeared to lose none of its toxicity after ten days in the insectary, these materials had little or no residual toxicity after this interval ; 2-nitro-1,1-bis(parachlorphenyl)propane, although somewhat slow in producing initial toxic symptoms and death, was shown to have better residual toxicity than most of the chlorinated hydrocarbons. Fresh deposits of technical and refined BHC required 25 and 53 hours, respectively, to knock down 50 per cent. of the weevils and showed practically no residual toxicity; toxaphene was superior to both. Although DDT was less effective than the other organic materials, fresh deposits killed up to 40 per cent. of the weevils in 96 hours.

Chandler (S. C.). **A comparative Study of Insecticides for Control of Plum Curculio.**—*J. econ. Ent.* **43** no. 1 pp. 73–75. Menasha, Wis., 1950.

Large-scale tests were carried out in four peach orchards in southern Illinois in 1949 to compare various treatments for the control of *Conotrachelus nenuphar*, Hbst. Most of the sprays were applied 5–8 times (the quantities given being per 100 U.S. gals.) and all the dusts 10–11 times, and records were made of the numbers of adults jarred from the trees between flowering and harvest, the percentages of fruits showing punctures resulting from oviposition or feeding by the adults (stung fruit) at the time of the normal June drop and at harvest and the percentages of infested fallen fruits in June and of infested fruits at harvest. Sprays containing 4 or 8 oz. aldrin [1,2,3,4,10,10-hexachlor - 1,4,4a,5,-8,8a - hexahydro - 1,4,5,8 - diendomethanonaphthalene] or 2 lb. 15 per cent. parathion were the best, and a spray of 2 lb. lead arsenate and dusts of 10 per cent. lead arsenate or 1 per cent. γ BHC (benzene hexachloride) the worst by all methods of computing results. In these tests, and also in one on apples, sprays of 1 lb. chlordan were superior to 4 lb. BHC powder containing 6 per cent. γ isomer, because the latter did not kill the adults quickly so that the percentages of stung fruit were high. A dust containing 1 per cent. parathion, which came between the two, seemed much more effective when used at 1 lb. per tree than at 8 oz. A spray of 4 oz. dieldrin [1,2,3,4,10,10-hexachlor - 6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro - 1,4,5,8-diendomethanonaphthalene] applied twice, which came third in final order of efficiency, resulted in small numbers of jarred adults, of stung fruits in June and at harvest and of infested fruits in June, but fairly large numbers of infested fruits at harvest, possibly because the interval between the second application and harvest (29th April to 6th August)

was too long. Fruits sprayed seven or eight times with BHC or in some cases with aldrin tasted musty, but fruits sprayed only five times with either material or dusted with BHC did not. No other materials affected flavour.

TASCHENBERG (E. F.). **An Appraisal of some Chlorinated Hydrocarbon and Organic Phosphate Insecticides for Grape Berry Moth Control.**—*J. econ. Ent.* **43** no. 1 pp. 76–81, 4 refs. Menasha, Wis., 1950.

Polychrosis viteana, Clem., was unusually abundant in the Chautauqua grape belt of New York during 1949, possibly because the preceding winter was mild and unusually high temperatures prevailed during the growing season ; the grape crop was light. Investigations were therefore carried out on the control of the larvae with organic compounds [*cf. R.A.E.*, A **38** 246]. These were first applied to heavily infested vines (34–77 per cent. injured fruits) twice against the first generation and once or twice against the second, the chlorinated hydrocarbons in bordeaux mixture and the organic phosphates with ferric dimethyldithiocarbamate in the first two applications and a copper compound of low solubility in the others. A miscible oil was added as a spreader and adhesive. Spray quantities are given per 100 U.S. gals. When DDT and DDD (dichlordiphenyldichlorethane) were each applied at 1 lb. against the first generation and at 12 oz. against the second and methoxy-DDT (methoxychlor) and methyl-DDT (ditolyltrichlorethane) at 1 lb. against both, three and four applications of DDT gave 96 and 97 per cent. control, respectively, and three and four of methoxy-DDT 93 and 95 per cent. DDD and methyl-DDT were less effective. In other tests, three and four applications of 8 oz. parathion gave 98 and 99 per cent. control and three or four of 4 oz. parathion, three of 12 oz. DDT and two of 12 oz. DDT followed by one of 4 oz. parathion all gave at least 95 per cent., but three or four of 8 oz. O,O-dimethyl S-(2-oxo-2-ureidoethyl) dithiophosphate or S-carbamylmethyl O,O-dimethyl dithiophosphate gave less than 50.

When two applications were made against the second generation only, 4 and 8 oz. parathion, 12 oz. DDT and 1 and 1·5 lb. methoxy-DDT gave at least 93 per cent. control, but DDT at 2 oz. gave only 85 per cent. One application of any of the chlorinated hydrocarbons practically eliminated infestation by *Erythroneura comes*, Say, but the organic phosphates were less effective, though they gradually reduced the population when applied repeatedly. No spray injury was observed on fruit or foliage treated with any of the materials.

In further tests, single applications were made after the larvae had become established in the fruit, when 2 and 4 oz. parathion killed practically all those in the first three instars, but 8 oz. appeared to be necessary to give 90 per cent. kill of the fourth instar. In several instances, parathion was used in Bordeaux mixture, with no decrease in efficiency. Tetraethyl pyrophosphate, the two dithiophosphates, 2-nitro-1,1-bis(parachlorphenyl) butane, DDT and DDD had little value against larvae feeding in the fruit. The toxic residue from one application of 4 oz. parathion was less than one part per million after seven days and less than 0·1 p.p.m. after three weeks.

GYRISCO (G. G.) & MARSHALL (D. S.). **Further Investigations on the Control of the Clover Root Borer in New York.**—*J. econ. Ent.* **43** no. 1 pp. 82–86, 4 refs. Menasha, Wis., 1950.

In further investigations in New York in 1949 on the value of organic insecticides against *Hylastes* (*Hylastinus*) *obscurus*, Marsh., on clover [*cf. R.A.E.*, A **38** 204], dusts were applied with a hand-operated fertiliser spreader or with a power duster in several localities on 12th–13th May, collections from adhesive traps at Minetto having shown that adult flight reached a maximum

by the second week. BHC (benzene hexachloride) at rates of 0·5, 0·75, 1 and 1·25 lb. γ isomer per acre increased the percentages of plants uninfested to 96·7, 96·7, 93·3 and 86·7 as compared with 46·7 on controls, the differences required for significance and high significance being 33·6 and 48·9. Hay yields were not affected, owing to abnormal growing conditions, but it appeared that at least 0·75 lb. γ BHC per acre would be needed for practical control. Residues at harvest were negligible, averaging less than 2 parts per million. When parathion was applied at 0·5, 0·75, 1 and 1·25 lb. per acre, the percentages of plants uninfested were 43·3, 73·3, 70 and 70 as compared with 46·6 for no treatment, while the difference required for significance was 28·3. In a third experiment, 1,2,3,4,10,10-hexachlor-1,4,4a,5,8,8a-hexahydro-1,4,5,8-di[endo] methanonaphthalene and 1,2,3,4,10,10-hexachlor-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-di[endo]methanonaphthalene [commonly known as aldrin and dieldrin, respectively] at 2 lb. per acre were as effective as BHC at 1 lb. γ isomer; parathion at 1 lb. per acre was less effective but gave highly significant control, 2 lb. chlordan gave erratic results and 4 lb. methoxy-DDT (methoxychlor) and 4 lb. toxaphene showed little promise. Tests of almost pure γ BHC on 20 varieties of red clover showed that food-plant differences did not affect the susceptibility of the Scolytid; although no variety was immune from infestation, a few were only lightly infested. Parathion and methoxy-DDT, at 1 and 5 lb. per acre, respectively, were completely ineffective when application was delayed until 21st May.

Fleming (W. E.). **Persistence of Effect of DDT on Japanese Beetle Larvae in New Jersey Soils.**—*J. econ. Ent.* **43** no. 1 pp. 87–89, 1 ref. Menasha, Wis., 1950.

The following is based on the author's summary. Tests of the effectiveness and persistence of DDT applied at the rate of 25 lb. per acre in controlling larvae of *Popillia japonica*, Newm., in soil were begun in the laboratory with 28 types of soil from New Jersey in 1943 and in field plots of turf in New Jersey, North Carolina, Connecticut or Massachusetts in 1944–48. The DDT was mixed with the soil in the laboratory at a rate equivalent to treating to a depth of three inches and applied to the surface as a dust in the field.

When the treatment was applied in the spring, it caused a substantial reduction in the larval population and practically eliminated subsequent generations by the middle of September. In the field, no significant change in the effectiveness of the treatment was noted in five years, but in the laboratory there was a marked decrease in the speed of insecticidal action in some of the soils during the fifth year.

The speed of action was not affected by the origin of the soil, but was lower in poorly drained, inadequately aerated soils. It was 50 per cent. higher in sands than in gravelly loams, shale loams, sandy loams, loams and silt loams. In the sands, it showed no significant change in five years, but in soils of other texture there was a reduction in the rate during the fifth year. It is concluded that DDT is as persistent as lead arsenate for soil treatment.

Ginsburg (J. M.), Filmer (R. S.) & Reed (J. P.). **Longevity of Parathion, DDT and Dichlorodiphenyl Dichloroethane Residues on Field and Vegetable Crops.**—*J. econ. Ent.* **43** no. 1 pp. 90–94, 14 refs. Menasha, Wis., 1950.

The following is based on the authors' summary. The results are given of further investigations on the recovery of organic insecticides from treated crops carried out in New Jersey in 1949 [*cf. R.A.E.*, A **38** 276]. Analyses of parathion, DDT and DDD (dichlordiphenyldichlorethane) were made on field and vegetable crops to ascertain how much toxic residue remained on the plants at harvest and whether the compounds were translocated or absorbed in edible

plant tissues. The plants were grown in experimental plots and on commercial farms, and the insecticides were applied as dusts and sprays for practical insect control. Plant samples were collected before and during harvest and extracted with benzene, the solvent was evaporated and the residues were analysed by colorimetric methods.

Parathion residues were analysed on lucerne, maize, onion, pea and turnip. Virtually no parathion was recovered from crops harvested 12 or more days after the last application of 0·5–1 per cent. dusts or of sprays giving 0·125–0·25 lb. parathion per acre, but pea plants sprayed with 0·5 lb. parathion per acre showed 0·1 part per million at harvest, 19 days after spraying. Maize plants dusted five times with 3 per cent. DDT or 5 per cent. DDD and harvested 13 days after the last application bore 13·1 p.p.m. DDT and 20·3 p.p.m. DDD, respectively. The rainfall during the interval was only 0·99 in. This indicates that in the absence of sufficient rain, comparatively large DDT and DDD residues may be retained by maize plants at harvest.

Translocation analyses were made on various plants dusted or sprayed with parathion, or grown in soil treated with it, and on maize dusted with DDT or DDD. None of the toxicants was translocated in any appreciable quantity in the plant tissues.

Doutt (R. L.) & Hagen (K. S.). **Biological Control Measures applied against *Pseudococcus maritimus* on Pears.**—*J. econ. Ent.* **43** no. 1 pp. 94–96, 3 refs. Menasha, Wis., 1950.

Further investigations on the distribution of eggs of *Chrysopa californica*, Coq., to prevent the increase of a mealybug, thought to be a race of *Pseudococcus maritimus*, Ehrh., on pear trees sprayed against the codling moth [*Cydia pomonella*, L.] in the Santa Clara valley of California were carried out in 1949 [*cf. R.A.E.*, A **38** 258]. Colonisation was more effective on 15th April, when petal-fall was nearly complete and a few naturally deposited *Chrysopa* eggs could be found in the orchards, than a fortnight later ; a small number of eggs at the proper time gave better results than a larger number on a less favourable date, and releases begun at the proper time and repeated at intervals were the most effective. The number of eggs distributed per tree ranged from 250 to 1,500, and the best results were obtained by using 750 in three successive lots of 250. This practice extends the effective feeding time of the *Chrysopa* larvae, and it is important that this feeding period should coincide with the presence on the trees of the immature mealybugs of the overwintered generation. Scattering the loose *Chrysopa* eggs along the lateral branches was not more effective than pouring them all into the crotch of the tree, which required much less time ; the larvae are very active and disperse throughout the tree from this point.

The percentages of fruits infested by the mealybug were 12 on trees receiving three lots of 250 *Chrysopa* eggs, 20 in plots in which eggs had been distributed in the previous year, and 58–68 in control plots.

Finney (G. L.). **Mass-culturing *Chrysopa californica* to obtain Eggs for Field Distribution.**—*J. econ. Ent.* **43** no. 1 pp. 97–100, 5 refs. Menasha, Wis., 1950.

The author describes modifications in the method of laboratory culture of *Chrysopa californica*, Coq., in California [*cf. R.A.E.*, A **38** 16], which have made it possible to obtain several hundred thousand eggs daily in the insectary. Severe infection of the breeding stock of the host (*Gnorimoschema operculella*, Zell.) by *Nosema destructor* was eradicated by immersing the egg-covered sheets for 20 minutes in a bath at 117°F. This treatment killed the spores of the

protozoa and did not impair the viability of the moth eggs ; it should be applied when the eggs are not more than 24 hours old. As the dry dust-borne spores are viable for 38–168 days, treatment should be continued as long as there is any threat of reinfection. The spores of *Plistophora californica*, which does not seem to harm the host material but reduces the life span and egg-production of adults of *Chrysopa*, were killed only by temperatures damaging the viability of the moth eggs, so that infection with these protozoa could not be eradicated from the host stock. However, nonviable eggs were more suitable than viable ones as food for *Chrysopa*, and host eggs and larvae destined for *Chrysopa* were therefore immersed for five minutes in a water bath heated to 135°F., which killed the spores. The number of *Chrysopa* eggs used in each larval culture unit was increased to 1,100, the first egg sheet was no longer covered until the second was put over it, and 40, 30 and 40 gm. processed host larvae were scattered between the egg-sheets three, five and seven days, respectively, after the second egg sheet was added. The *Chrysopa* cocoons were immersed in a bath of 21 per cent. sodium hypochlorite in water (1 : 30) for 20 seconds to loosen débris and in isopropyl alcohol diluted with water to a specific gravity of 0·92 to allow it to sink away from the cocoons. A marked increase in egg-production was obtained by feeding the *Chrysopa* adults on a protein hydrolysate of yeast instead of on honeydew of *Pseudococcus citri*, Risso [*cf.* next abstract], and the intense nocturnal swarming and the daytime inactivity of the adults was changed to a calm steady movement by excluding all outside light and exposing them to continuous artificial light.

Sheets of eggs to be distributed in the field [*cf.* preceding abstract] were immersed for four seconds in a bath of 21 per cent. sodium hypochlorite in water (1 : 30) heated to 24°C. [75·2°F.] to dissolve the egg stalks, held out of the bath for 16 seconds and then sprayed with water, which washed the eggs off the sheets. They were then collected, dried and measured volumetrically into small units suitable for field distribution.

HAGEN (K. S.). **Fecundity of *Chrysopa californica* as affected by synthetic Foods.**—*J. econ. Ent.* **43** no. 1 pp. 101–104, 1 fig., 3 refs. Menasha, Wis., 1950.

Insectary rearing of *Chrysopa californica*, Coq., in California was handicapped by the time and labour involved in obtaining honeydew of *Pseudococcus citri*, Risso, as supplementary food for the adults [*cf. R.A.E.*, A **38** 16]. In attempts to obtain a synthetic substitute, it was found that adults fed on a protein-free diet laid few eggs, and dissection showed that ovisorption occurred in those fed only on honey. Dextrin and the sugars that occur in honey (laevulose, dextrose and sucrose) in combination and alone, failed to supply the nutritional factors essential for egg-production, indicating that the sugars in honeydew had a negligible influence on fecundity. Various proteins all stimulated egg-production, and a 40 per cent. solution of a freely soluble enzymatic hydrolysate of primary grown brewer's type nutritional yeast (MRT) was the most promising. This contained free amino acids, polypeptides and all factors of the vitamin B complex found in yeast, and not only led to higher fecundity than honeydew from *P. citri* [*cf.* preceding abstract], but also increased the length of life. It was evident that *Chrysopa* adults did not need water at high humidities, the hygroscopic action of the synthetic foods then providing sufficient for normal survival and oviposition.

When the yeast compound was offered to adults of *C. majuscula*, Banks, they fed little if at all and did not oviposit ; in nature they feed directly on Aphids. It would, however, probably prove beneficial in the case of other honeydew-feeding species.

Beck (S. D.). **The Toxicology of Antimycin A.**—*J. econ. Ent.* **43** no. 1 pp. 105–107, 1 fig., 7 refs. Menasha, Wis., 1950.

The author states that unpublished experiments by Kido have shown that antimycin A, a recently discovered and isolated antibiotic, has insecticidal possibilities for at least a few species of insects and mites. In the experiments here described, it had no observable effect on cockroaches when ingested with food, but was very toxic when injected into the body cavity as a maize-oil solution or an emulsion in saline. Injection resulted in a depression of oxygen consumption, cardiac failure, sluggishness and death. The symptoms were consistent with the hypothesis that antimycin A inhibits the succinoxidase system or some other essential step in the oxidative metabolic cycle.

Smith (L. M.) & Lange jr. (W. H.). **Larvae of *Hoplia oregona* on Strawberries.**—*J. econ. Ent.* **43** no. 1 p. 107. Menasha, Wis., 1950.

Larvae of the Melolonthid, *Hoplia oregona*, Lec., were found severely damaging the roots of strawberries in a plot near Modesto, California, in March 1949. The plants were growing in unlevelled sandy soil and those on the higher and lower parts were suffering from improper soil moisture. The larvae did not occur where the plants were properly watered and had made vigorous growth, but were abundant wherever the plants were unthrifty ; there were 5–16 larvae per infested plant and they occurred mainly at a depth of 1–2·5 ins., with none deeper than 4 ins. They preferred the new succulent white roots, which were eaten to one inch below the soil surface, but in default of these, they fed on the bark of old brown roots and ate to the stele. Many of the infested plants were quickly killed, but most survived in a dwarfed and unproductive condition.

Typical emergence holes were found in a field of lucerne and one of rye near the strawberry plot, but the population density was much lower there. E. M. Stafford reported that he had reared the larvae from the roots of rose. Adults emerged in the field during the first two weeks of May.

Control was attempted by injecting 10 per cent. commercial ethylene dibromide in naphthal thinner at 2 cc. per hole into holes 12 ins. apart arranged alternately in two rows, one on each side of the raised strawberry bed. There was no mortality two days later, but no living larvae could be found in the treated area after a week. No symptoms of chemical injury to the plants were observed 16 days after treatment.

Shelford (V. E.). **Termite Treatment with aqueous Solution of Chlordane.**—*J. econ. Ent.* **43** no. 1 pp. 107–108, 1 ref. Menasha, Wis., 1950.

In further tests of the soil near a house in Illinois that was treated with chlordan in the autumn of 1947 for the control of termites [*cf. R.A.E.*, A **38** 251], samples taken 0·5–2 ins. from the wall and at depths of 3–8 ins. in November 1949 caused paralysis of most of the termites confined in contact with it in 2–3 hours and complete cessation of movement 24 hours after paralysis began. The statement that death occurred in 24 hours in 1948 [*cf. loc. cit.*] is thought to have been incorrect, as close examination with a lens in 1949 showed twitching of the appendages for at least 4–5 days after complete body paralysis. Termites in untreated sandy soil remained active and in good condition. There appeared to be no difference in the toxicity of the soil in 1948 and 1949 or between samples from different depths or from points that had received different amounts of aqueous solution.

Further pieces of trunks of cherry and *Ailanthus* that were put in the test area [*cf. loc. cit.*] early in the summer of 1948 had an abundance of termites beneath them within a few days, but the cherry was almost completely

destroyed and the *Ailanthus* abandoned and intact in November. A *Forsythia* twig from the year before was only slightly damaged. The cherry tree that was treated with 0·25 per cent. aqueous chlordan against termites and ants contained no example of either in the hollow interior when it was removed two years after treatment.

Greenwood (D. E.) & Hofmaster (R. N.). **The Efficiency of several new Insecticides for the Control of *Hymenia fascialis* on Fall Spinach.**—*J. econ. Ent.* **43** no. 1 p. 108, 1 ref. Menasha, Wis., 1950.

In the autumn of 1949, when all spinach in the Norfolk area of Virginia was infested by larvae of *Hymenia recurvalis*, F. (*fascialis*, Stoll), regardless of planting date, various insecticidal dusts were applied against them at about 40–50 lb. per acre with a self-propelled duster. The results were estimated by counting the living larvae on groups of 25, 10 and 15 severely injured plants 24, 72 and 120 hours after treatment. The numbers were 2, 10 and 73, respectively, for 1 per cent. γ BHC [benzene hexachloride], parathion and dieldrin [1,2,3,4,10,10-hexachlor-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-diendomethanonaphthalene], 13 for 2·5 per cent. aldrin [1,2,3,4,10,10-hexachlor-1,4,4a,5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene], 6 for 3 per cent. fluoro-DDT (DFDT) and 5 for 5 per cent. DDT after 24 hours and 0 for all these insecticides after 72 hours. Plants dusted with 5 per cent. methoxy-DDT (methoxychlor) showed 17 after 24 hours and three after 72, and those receiving 10 per cent. toxaphene, 40 per cent. *Ryania* and a mixture of 0·5 per cent. piperonyl cyclonene, 0·5 per cent. pyrethrins and 0·25 per cent. rotenone showed no reductions in numbers of living larvae after 24 hours but had 0, 17 and 12 after 72 hours ; the last two had 9 and 4 after 120 hours. The numbers on untreated plants were 128 after 24 hours and 61 after 120.

Although *Ryania* and the mixture of pyrethrum, rotenone and synergist were slow in action, they gave good final control and might be substituted for other insecticides when residues are important. On spinach being grown for seed, a dust of 1 per cent. tetraethyl pyrophosphate gave excellent control when applied with a rotary hand duster.

Turner (N.). **Counteracting the Effect of Benzene Hexachloride on Flavor of Potatoes.**—*J. econ. Ent.* **43** no. 1 p. 109. Menasha, Wis., 1950.

Preliminary tests carried out in Connecticut in 1949 to find methods of preventing the persistent tainting of potatoes grown in soil treated with BHC (benzene hexachloride) at 2·5 lb. per acre to control wireworms showed that the addition of activated charcoal to the soil at the rate of 1 ton per acre removed the foreign flavour completely and that hydrated lime at 5 tons per acre was almost as effective. Liquid lime-sulphur at 12·5 and 25 lb. per acre gave some relief, but itself affected the flavour, and neither ferric chloride nor alcoholic potash gave good results. Treatment with activated charcoal or hydrated lime at these rates is not practicable, but the results obtained indicate that corrective treatments can be developed to remove BHC from the soil.

Polivka (J. B.). **Parathion to control Bagworms.**—*J. econ. Ent.* **43** no. 1 p. 109. Menasha, Wis., 1950.

Thyridopteryx ephemeraeformis, Haw., has damaged various trees in southern Ohio for many years and has been particularly injurious to arbor-vitae [*Thuja*] and at times to spruce. A heavily infested arbor-vitae tree that was sprayed

with 1 lb. chlordan per 100 U.S. gals. water on 27th July 1949 showed no control a week later, but one sprayed on the same date with 1 lb. parathion per 100 U.S. gals. was completely free of living larvae. The parathion spray was applied to six additional trees on 3rd August, and no living larvae were found on them on 2nd September or 25th October, though untreated trees showed no dead larvae.

Bean (J. L.). **Parasitization of Syrphid Larvae and Puparia.**—*J. econ. Ent.* **43** no. 1 pp. 109–110, 2 refs. Menasha, Wis., 1950.

On 25th August 1945, Syrphid larvae were observed feeding on Aphids on the new growth of heavily infested red pine [*Pinus resinosa*] at Augusta, Maine. Seventeen larvae and 25 puparia were taken to the laboratory, where 13 further puparia were obtained. Parasites emerged from 28 of the puparia, the Pteromalid, *Pachyneuron allograptae*, Ashm., the Cynipid, *Callaspidia provancheri*, Ashm., and the Ichneumonids, *Diplazon* sp., *D. laetatorius*, F., and *D.* (*Syrphoctonus*) *agilis*, Cress., from 7, 7, 1, 4 and 3 of *Metasyrphus wiedemanni*, Johnson, *P. allograptae* from 5 of *Allograpta obliqua*, Say, and *C. provancheri* from an undetermined puparium that resembled that of *Syrphus ribesii* var. *vittafrons*, Shann. Two adults of *M. wiedemanni* emerged ; the rest of the material died. The four identified parasites all emerged from puparia reared in the laboratory as well as from those collected in the field.

Plumb (G. H.). **Control of *Scolytus* and Dutch Elm Disease by concentrated DDT Sprays.**—*J. econ. Ent.* **43** no. 1 pp. 110–111, 3 refs. Menasha, Wis., 1950.

The results are given of experiments begun in New Haven, Connecticut, in the spring of 1948 to determine whether large elm trees growing in an area in which the rate of infection by Dutch elm disease [*Ceratostomella ulmi*] was high could be protected by sprays directed against the vector, *Scolytus multistriatus*, Marsh. ; 101 trees 7–40 ins. in trunk diameter were sprayed and 101 6–37 ins. in diameter kept as controls. A mist blower with an output of slightly more than 1 U.S. gal. spray and about 8,400 cu. ft. of air per minute at a velocity of 140 miles per hour was used to apply 12·5 per cent. DDT in emulsified xylene when the trees were dormant ; half the trees were sprayed again with the emulsion at half strength just before flowering and the emergence of the summer generation of beetles. The dosage per tree necessary to give adequate coverage of the twigs was not known, but the trees were sprayed until thoroughly covered. Subsequent analysis showed that dosage could be correlated with trunk diameter but not with tree height, and it is estimated to be 1 U.S. gal. for a 10-in. tree, to be increased by 1 U.S. gal. for each additional 5 ins. The mean dosage at the dormant stage was 4·2 U.S. gals. spray (4·2 lb. DDT) in 1948 and 4·3 in 1949.

Periodic examination of the trees for disease showed that 3 of the sprayed trees and 21 of the others were infected in early September 1948 and 9 of the sprayed and 39 of the others at the end of August 1949. The fact that five of the infected trees were sprayed once each year and four twice indicated that the single dormant application was about as effective as the double treatment. The mist blower was well adapted for the treatment of urban shade trees, as it involved less danger of poisoning birds and animals or of damaging other plants than hydraulic equipment. During the experiments described,

no plant injury was caused and there was no increase in mite population, such as frequently accompanies hydraulic spraying with DDT.

BERRY (R. C.). **Ryania for Control of Cranberry Fruitworm.**—*J. econ. Ent.* **43** no. 1 p. 112. Menasha, Wis., 1950.

Experiments were carried out in Massachusetts in 1949 on the effectiveness of *Ryania*, rotenone and cryolite in sprays and dusts against *Mineola vaccinii*, Ril., on cranberry. Plots were arranged at random throughout most of the cranberry-growing areas, and the sprays were applied at 500 U.S. gals. and the dusts at 50 lb. per acre. The percentages of berries infested on 2nd August were 4, 6 and 15 for sprays of 7 lb. *Ryania* with 1 lb. wetting agent (Ultrawet DS) per 300 U.S. gals. water, 7 lb. 5 per cent. rotenone with 2 lb. fish-oil soap per 100 U.S. gals. and 6 lb. cryolite per 100 U.S. gals., respectively, as compared with 84 for no treatment, and 7, 8 and 17 for dusts of 40 per cent. *Ryania* in pyrophyllite, 5 per cent. rotenone in pyrophyllite and undiluted cryolite, as compared with 79. Cryolite, which has been widely used by growers in recent years, was thus the least effective material.

SEVERIN (H. H. P.). *Acinopterus angulatus*, **a newly discovered Leafhopper Vector of California Aster-yellows Virus.**—*Hilgardia* **17** no. 5 pp. 197–205, 1 col. pl., 7 refs. Berkeley, Calif., 1947.

DELONG (D. M.) & SEVERIN (H. H. P.). **Taxonomy, Distribution, and Food Plants of** *Acinopterus angulatus*.—*T.c.* pp. 211–215, 6 figs., 8 refs.

The second paper contains a description of the adult of *Acinopterus angulatus*, Lawson, which is stated to be widespread in California, Arizona, Texas, Mexico, Central America, South America and the West Indies. In California, where it was first observed in 1935, it has been found on lucerne in several areas and locally on *Lotus americanus* and *Glycyrrhiza lepidota*, and adults have been taken on pasture vegetation, weeds, and Ladino clover (*Trifolium repens* var. *latum*).

In the first paper, details are given of laboratory experiments in which the virus of California aster yellows in celery or aster was transmitted by adults of either sex of this Jassid. When adults reared on infected plants were confined singly on healthy ones, 8 of 100 transmitted the disease from celery to celery and 9 out of 100 did so from aster to aster, but further experiments in which higher percentages of infection and infection of successive batches of plants (including celery, aster or both) were obtained by transfer of batches of adults indicated that celery was more easily infected than aster, and that an increase of the feeding period on the healthy plant increases the likelihood of its infection. In a test in which five batches of 80 previously uninfected adults were fed for one day on infected celery and the survivors were transferred daily to healthy celery plants for 41 days, the minimum latent period of the virus in the leafhoppers ranged from 11 to 26 days. The number of plants infected by the batches ranged from two to seven, and three batches transmitted the disease on the 40th or 41st day. Of seven adults kept singly and transferred daily to healthy plants after having been shown to have transmitted the disease, only one transmitted it again, but this one did so after retaining the virus for at least 51 days.

Batches of adults did not transmit the virus of curly-top from infected to healthy sugar-beet or the virus that causes both Pierce's disease of grape vines and alfalfa dwarf from infected to healthy grape vines and lucerne, respectively. Adults of *A. parallelus*, Beamer, failed to transmit the virus of California aster yellows from diseased to healthy celery.

Severin (H. H. P.). **Plant Symptoms induced by Feeding of some Leafhopper Species.**—*Hilgardia* **17** no. 5 pp. 217–221, 4 pls., 1 fig., 3 refs. Berkeley, Calif., 1947.

In the course of investigation on the Jassid vectors of the virus of California aster yellows, ten species were found to induce symptoms on aster or celery as a result only of the saliva or feeding [*cf. R.A.E.*, A **34** 227]. They were *Texananus latipex*, DeL., *T. lathropi*, Baker, *T. pergrada*, DeL., *T. spatulatus*, Van D., *Gyponana hasta*, DeL., *Colladonus montanus*, Van D., *C. geminatus*, Van D., and *Cloanthanus irroratus*, Van D., on celery, and *Acinopterus angulatus*, Lawson, and *Idiodonus heidemanni*, Ball, on aster. The symptoms, which in general comprise various degrees of vein-clearing, vein-banding and chlorosis, are described for each species.

Bohart (R. M.). **Sod Webworms and other Lawn Pests in California.**—*Hilgardia* **17** no. 8 pp. 267–308, 20 figs., 34 refs. Berkeley, Calif., 1947.

The greater part of this paper comprises an account of the results of investigations on *Crambus bonifatellus*, Hulst, and *C. sperryellus*, Klots, the principal pests of lawns in California [*cf. R.A.E.*, A **29** 408]. Their economic history, geographical distribution, range of food-plants and taxonomy are discussed, all stages are described, and characters distinguishing the larvae, pupae and adults are given. *C. sperryellus* is the species that was previously recorded in error from California as *C. leachellus*, Zinck. [**20** 174], which also occurs there, and *C. cypridalis*, Hulst [**18** 171–172].

The following is based on the author's summary. Injury to lawns in California by *Crambus* was first reported in 1929 [*cf.* **18** 171] and has been considerable every year since then. *C. bonifatellus* occurs throughout the Canadian zone of the Rocky-mountain and Great-basin area and has been collected in British Columbia and Oregon. In California it occurs near the sea. *C. sperryellus* is restricted mainly to California, where it is common along the coast and throughout the Sacramento and San Joaquin valleys ; in southern California it ranges inland as far as the San Bernardino Mountains, Needles and the Coachella Valley. Although blue grass (*Poa*) and bent grass (*Agrostis*) are preferred, laboratory feeding studies showed that many other grasses and clover are potential food-plants.

The eggs are scattered by the female during the oviposition flight, which begins just before dusk and lasts about an hour. The average number per female is 200–300, though more than 500 are sometimes produced ; *C. bonifatellus* appears to be somewhat more fecund than *C. sperryellus*. A few moths are attracted to artificial light towards the end of the oviposition period and sometimes for several hours thereafter. In the laboratory, *C. bonifatellus* was reared from egg to adult in an average of 35·9 days at about 75°F., the egg, larval and pupal stages lasting 4·5, 23·7 and 7·7 days, respectively. At 59°, development from egg to adult averaged 133·7 days. *C. sperryellus* was reared from egg to adult in an average of 54·8 days at 75°, the egg, larval and pupal stages lasting 6, 37·6 and 11·2 days. In California, the webworms appear to breed continuously throughout the late spring, summer and early autumn, and the period from late October to late April is customarily passed in a semiquiescent state by mature or nearly mature larvae. In the Los Angeles area, *C. bonifatellus* apparently completes four generations a year and *C. sperryellus* only three. Two undescribed Braconids of the genera *Orgilus* and *Apanteles*, and a Tachinid, *Zenillia* (*Aplomya*) *confusionis*, Sellers, were reared from both species infesting lawns, and these occasionally appeared to give considerable control. The most important predators were the Brewer blackbird, *Euphagus cyanocephalus*, the Vespids, *Vespula pennsylvanica*, Sauss.,

Polistes fuscatus aurifer, Sauss., and *P. anaheimensis*, Prov., the earwig, *Euborellia annulipes*, Lucas, the Carabids, *Celia californica*, Dej., and *Agonoderus lineola*, F., and Staphylinids.

Several insecticides gave adequate temporary control when applied in sufficient concentrations [*cf.* **29** 408], but only acid lead arsenate, which was best applied at 5 lb. in 50 U.S. gals. water per 1,000 sq. ft., prevented reinfestation.

Other pests of lawns observed by the author in California are the Hesperiid, *Hylephila phylaeus*, Dru., the cutworms, *Cirphis unipuncta*, Haw., *Feltia subterranea*, F., and *Peridroma saucia*, Hb. (*margaritosa*, Haw.), the Pyralid, *Nomophila noctuella*, Schiff., the ants, *Pogonomyrmex californicus*, Buckley, and *Solenopsis xyloni maniosa*, Wheeler, Lamellicorns, chiefly *Spilosota hirta*, Lec., *Sphenophorus* (*Calendra*) spp., the Mirid, *Leucopoecila albofasciata*, Reut., Jassids, particularly *Draeculacephala mollipes*, Say, and the woodlice, *Armadillidium vulgare*, Latr., and *Porcellio laevis*, Latr. Brief notes are given on their control and on the bionomics of some of them. There are two lawn diseases in California, caused by fungi of the genus *Rhizoctonia*, that are sometimes confused with injury by *Crambus*, but the latter is distinguished by unevenness of grass height and irregularity in the shape of the dead spots. A conclusive test for the presence of the webworms is to water the grass with dilute pyrethrum extract to bring the larvae to the surface. Another indication of infestation is an abundance of parasites and predators in the turf or hovering above it.

HERMS (W. B.). **Some Problems in the Use of artificial Light in Crop Protection.**—*Hilgardia* **17** no. 10 pp. 359–375, 1 fig., 22 refs. Berkeley, Calif., 1947.

The author summarises and discusses the results of experiments in California on the control of insects by means of artificial light, of which all except one [*R.A.E.*, A **21** 163] comprised tests of electrocuting light-traps under field conditions, carried out over a period of more than 12 years against *Cydia* (*Carpocapsa*) *pomonella*, L., on apple and pear, *Erythroneura comes*, Say, on grape, *Platyptilia carduidactyla*, Ril., on artichoke [*Cynara scolymus*], *Heliothis armigera*, Hb., on tomato, and insects attacking figs in a drying yard. Many of them have already been noticed [*cf. R.A.E.*, A **23** 36, 729 ; **30** 553]. Laboratory experiments on some of the insects indicated a possible specific colour selection, so that if light-traps could be devised with colours appropriate to certain phototactic insect pests, a method of crop protection that would not destroy beneficial insects in appreciable numbers might be developed. This would avoid poisonous insecticide residues on crops and deleterious effects from the accumulation of poisons in the soil. However, much more laboratory and field work will be necessary to prove the theory of colour selection conclusively and to make practical use of the results. A thorough knowledge of the natural behaviour of the insect under all ecological conditions is essential in this type of investigation. Many problems are encountered, and attempts are made to evaluate the effects of climatological factors, position of traps, intensity and wave-length of light and size of light source, each of which must be considered with adequate knowledge of the particular species concerned.

Light-traps offered little promise against *C. pomonella* [*cf.* **23** 36, etc.], and the tests on tomato and artichoke were too limited to give conclusive results ; the engineering problems met in setting up a system of wiring for light-traps in cultivated fields differed materially from those in orchards. Economical and effective light-trap installations, used on a large scale in various parts of the San Joaquin Valley, resulted in markedly higher yields of grapes of high quality because of reduced damage by *E. comes*, but there is serious danger that such

traps may attract other Jassids infected with the virus of Pierce's disease of grape vines [*cf.* **33** 172] into the vineyards from some distance.

GRAYSON (J. M.). **White Grubs injurious to Peanuts in southeastern Virginia. Species in cultivated Soils and Response of three Species to different Soil Media.**—*Tech. Bull. Va agric. Exp. Sta.* no. 109, 12 pp., 1 map, 8 refs. Blacksburg, Va., 1947.

In connection with investigations of damage to groundnuts in south-eastern Virginia by larvae of *Strigoderma arboricola*, F. [*R.A.E.*, A **35** 250], observations were carried out on the species of Lamellicorn larvae that occur in fields there and the factors that affect their abundance.

Populations were investigated in 38 fields in 1945 and 52 in 1946 by collecting behind the plough in spring for a distance of about half a mile, or less if few or no larvae occurred, and larvae were found in 22 and 41 fields, respectively. Of the 18 species taken, a list of which is given showing details of frequency, *S. arboricola*, *Lachnosterna* (*Phyllophaga*) *ephilida*, Say, *Cyclocephala immaculata*, Ol., and *Cotalpa lanigera*, L., were the commonest in cultivated soil and *L.* (*P.*) *micans*, Knoch, in sod land. *S. arboricola* and *L. ephilida* were well distributed, while *Cyclocephala immaculata* and *Cotalpa lanigera* were less numerous and more limited as regards the variety of crops grown the previous year. *S. arboricola*, *L. ephilida*, *C. immaculata* and certain other species were most abundant in medium-stiff, moderately well-drained soils, while *C. lanigera* was commonest in light well-drained soils.

Total populations were little affected by soil type, but the fewest larvae were found in a dark soil with moderate to poor drainage. The numbers of larvae collected in fields that had been under maize, maize with soy beans, cotton, groundnuts, and sod or oats, averaged 24·7, 22, 18·5, 6·5 and 37·8, respectively, per field, but these numbers are not strictly comparable as the life-cycles of some species (mainly those of *Lachnosterna*) last more than a year and the number of fields examined (except in the case of groundnuts) was small. Adults of a few additional species of *Lachnosterna* and *Anomala* were also collected.

Laboratory experiments in which newly hatched larvae were reared in various media showed that larvae of *S. arboricola* and *L. ephilida* survived better and grew more rapidly in soil media that contained living plant tissue (sprouting wheat or maize) than in those without, regardless of the type of soil or its content of organic matter, while *Ligyrus gibbosus*, Deg., throve better in fine sandy loam soil with added organic matter than in the same soil with sprouted maize or in three different types of soil without added organic matter.

DEBACH (P.). **Cottony Cushion Scale, Vedalia and DDT in central California.**—*Calif. Citrogr.* **32** no. 9 pp. 406–407, 1 fig. Los Angeles, Calif., 1947.

Outbreaks of the cottony cushion scale [*Icerya purchasi*, Mask.], which had been controlled in central California by *Rodolia* (*Vedalia*) [*cardinalis*, Muls.] since the introduction of that Coccinellid in 1888–89, developed on *Citrus* from Edison to Hamilton City in 1946, following the widespread use of DDT on this and other crops throughout the area [*cf. R.A.E.*, A **36** 145 ; **37** 289]. They were apparently due to the elimination of *R. cardinalis* from the treated groves and occurred in some instances after only one application. Coccinellids coming from untreated areas controlled the Coccid in groves in which one or more DDT applications had been made before 1st July, but did not become established in those treated later. Since leaves completely covered with wettable DDT spray residue that had been weathered for over two months in the field

caused complete mortality of *Rodolia* adults in the laboratory, it was evident that adults that entered groves treated with DDT after 1st July were killed over a considerable period of time, and since such groves were the only ones still containing large populations of *Icerya*, they apparently tended to act as traps for the beetles. The Coccinellid was practically absent from the *Citrus* groves during the following winter and early spring, and this was not due to severe weather, since it occurred throughout the winter on city ornamental plants infested by *Icerya* in central California and on *Citrus* in southern California, where the weather was similar but the groves had not been treated commercially with DDT.

As intensive surveys in Kern and Tulare counties early in 1947 failed to reveal any *Rodolia* on *Citrus* by the middle of March, and *Icerya* was beginning to increase rapidly in some groves, initial liberations of *Rodolia* and of the parasite *Cryptochetum* [*iceryae*, Will.] were made in experimental groves on 21st March. *Rodolia* readily became established and completed one generation by 22nd April, and *Cryptochetum* was recovered in small numbers. Several thousands of *Rodolia* were released in other groves in April and May, and smaller numbers of *Cryptochetum* in April.

Investigations were begun to develop formulations of DDT and methods and times of application that would be least injurious to populations of *Rodolia*.

Dickson (R. C.) & Lindgren (D. L.). **The California Red Scale.**—*Calif. Citrogr.* **32** no. 12 pp. 524, 542–544, 1 fig., 3 refs. Los Angeles, Calif., 1947.

Aonidiella aurantii, Mask., which is the most serious pest of *Citrus* in southern California, was formerly apparently limited in distribution in the interior counties by high temperatures and low humidity, but has recently shown a marked tendency to increase in the warmer sections [*cf. R.A.E.*, A **36** 188]. It has become of considerable importance in the Redlands area and has appeared in commercial groves in Tulare County and the Coachella valley. The results are given of outdoor cage tests to determine the rate of development of the scale in different parts of southern California at different seasons in 1940 and of the maximum number of generations possible per year (2–3·6) in different places between 1st November 1939 and 1st November 1941. Development took 6–7 months in most areas in winter and a little over two months in the interior and about three months along the coast in summer. The warmer conditions at higher elevations, particularly at night, increased the rate of development slightly [*cf.* **37** 302], and a small-scale experiment at Riverside showed that the scales matured more rapidly on the south side of the trees than on the north side in winter, whereas there was little difference in summer. However, the much higher mortality on the south side more than offset any advantage due to more rapid development and explained frequent observation that in this area populations of *A. aurantii* are greatest on the north or north-east portions of *Citrus* trees.

The development of strains of *A. aurantii* resistant to hydrocyanic acid gas is discussed, and the distribution of resistant and non-resistant strains in the various *Citrus*-producing counties of California, as indicated by laboratory fumigation of samples, is shown in a table. It is concluded that as the length of time for which one treatment will give control is affected by the density of the treated population, the percentage kill and the rapidity of reproduction afterwards, a comparatively poor kill along the coast, where reproduction is slow, will be as effective as a good one in the interior ; growers near the coast who practice fumigation may therefore not be aware of the presence of resistant strains in their groves, whereas in the interior, the more rapid reproduction makes any poor kill obvious. This explains the rather common belief that resistant strains are confined to the interior districts, whereas the table shows

that although they are commoner in the interior than along the coast, they occur in all areas and now constitute an important part of the population.

DeBach (P.) & Fleschner (C. A.). **Biological Control of the Long Tailed Mealy Bug.**—*Calif. Citrogr.* **33** no. 1 pp. 22–24, 1 graph. Los Angeles, Calif., 1947.

Pseudococcus adonidum, L. (*longispinus*, Targ.) is still of only minor importance on *Citrus* in southern California and occurs principally in coastal areas of Orange, Los Angeles and Ventura counties. *Anarhopus sydneyensis*, Timb. *Tetracnemus peregrinus*, Comp., and *Anagyrus fusciventris*, Gir., were introduced for its control after the first outbreak in 1933 [*cf. R.A.E.*, A **29** 297–298], and the first two of these parasites became established and were thought to be controlling the mealybug until 1943, when an outbreak occurred in Orange County. The infested area increased in 1944 and 1945 until about 1,000 acres were affected, and similar increases on *Citrus* occurred during the same period in coastal areas of Ventura county. Detailed analyses of the populations of the mealybug and all its natural enemies, made monthly in 1946 and 1947, showed that several species as well as the introduced parasites were killing it. In 1946, six species of primary parasites were reared, of which *Anarhopus sydneyensis*, *T. pretiosus*, Timb., *Coccophagus gurneyi*, Comp., and *T. peregrinus* comprised 85, 9, 4 and 1 per cent., respectively, and seven predators were found, of which *Sympherobius californicus*, Banks, *Cryptolaemus montrouzieri*, Muls., and *Chrysopa californica*, Coq., comprised 74, 16 and 10 per cent. The mealybug began to increase rapidly in early spring, and natural enemies increased soon after, checking the outbreak by May and drastically reducing it by June, though not until the mealybug had reached injurious numbers in certain groves. Mealybug populations then remained low until the following spring. Field observations indicated that predators were primarily responsible for this control, since they were able to overtake the mealybug population, while the parasites were not. When predators were excluded from trees by treatment with DDT, which did not affect the principal parasites, it was evident that the latter, although beneficial, were much less effective than were the predators on untreated trees [*cf.* **36** 145]. In the spring of 1947, the mealybug began to increase again, but *S. californicus* did not become numerous so early as in 1946 and *Cryptolaemus* and *Chrysopa* did not control the scale increase so early or so effectively. General reductions did not usually occur until July. *Sympherobius* and *Chrysopa* gave the principal final control, though *Cryptolaemus* became common in certain groves ; parasites were again not effective.

Preliminary studies on the effect of various insecticides on predators and parasites of *P. adonidum* indicated that most residues, even certain non-toxic ones such as talc, may inhibit the increase of predators for an appreciable time. DDT is especially toxic and long-acting in its adverse effects on predators, but had no apparent effect on parasites [*cf.* **36** 145].

Laudani (H.). **A simplified Technique for rearing Carpet Beetles.**—*Soap & sanit. Chem.* **24** no. 10 pp. 139, 143, 2 figs., 1 ref. Baltimore, Md., 1948.

Two of the slowest processes in rearing carpet beetles on a large scale [*R.A.E.*, A **31** 318] have been the separating of the adults to begin new cultures and the sorting of the larvae either for a change of medium or for use in tests. In this paper, the author describes improved methods of separating the adults and larvae of *Attagenus piceus*, Ol., and *Anthrenus vorax*, Waterh., from the cultures by making use of the positive phototropism of the adults and the negative phototropism of the larvae. These have accelerated the operations considerably.

Sweetman (H. L.), Clark (E. L.) & Bourne (A. I.). **Smoke Dispensers for Insecticides.**—*Soap & sanit. Chem.* **24** no. 10 pp. 141, 143, 5 figs., 2 refs. Baltimore, Md., 1948.

The authors describe tests with canisters of various types each containing 25 ft. of cord (Cordacide) impregnated with DDT (not less than 20 per cent. by weight of the cord and not less than 0·45 gm. per ft.) to be burnt to provide an insecticidal smoke [*cf. R.A.E.*, A **37** 186]. The smoke produced is stated by the makers to remain in the air for 1–2 hours, penetrating cracks and crevices and finally leaving a uniform deposit of DDT on all surfaces, and dosages of 1 ft. cord per 60 cu. ft. for most household insects and 1 ft. per 30 cu. ft. for more resistant ones, such as carpet beetles, are recommended [*cf.* **37** 187]. When the cord was burnt in the basement of a very old house, the smoke readily penetrated through the two floors above, but very little smoke and no objectionable odour passed the loose-fitting door of an untreated room in another house receiving treatment, and there was no objectionable odour in the treated rooms after they were aired. A DDT cord used in a house lightly infested with carpet beetles and clothes moths gave complete control within a few days.

In laboratory tests in which the cord was burnt in a 25 cu. ft. chamber containing petri dishes on the floor and about 4 ft. up, and insects were placed in the dishes for observation after the settling of the DDT particles, contact with the deposits in different parts of the chamber was about equally effective. The full results are shown in a table, in which, however, the rates of application appear to have been reversed. A rate of 1 ft. of cord (0·45 gm. DDT) per 60 cu. ft. gave complete kills of adults of *Tribolium confusum*, Duv., *Oryzaephilus surinamensis*, L., and *Ephestia* sp., 80 per cent. kill of larvae of *Tenebrio molitor*, L., after exposure for nine days, and no mortality of larvae of *Anthrenus vorax*, Waterh., and one of 1 ft. cord per 30 cu. ft. gave complete kills of larvae of *T. molitor* and adults of *A. vorax* and *Bruchus* (*Acanthoscelides*) *obtectus*, Say, and 55 and 5 per cent. kill after nine days of larvae of *Anthrenus vorax* and *A. verbasci*, L., respectively. The results indicated that adults of *Tribolium*, *Oryzaephilus* and *Ephestia* would probably be killed on exposed surfaces. *Tenebrio* larvae would probably be killed in exposed situations or when feeding on grain débris in feed boxes or store rooms, and adults of *Anthrenus* and *Bruchus* would be killed in places from which they could not readily escape. *Anthrenus* larvae proved very resistant and would probably escape to unexposed crevices and materials in most buildings.

It is concluded that smoke-type aerosols of certain insecticides may be useful in limited areas against some insects, but there appears to be insufficient penetration of the smoke into hidden areas to eradicate carpet-beetle infestations, and recent tests in infested buildings confirm this. Considerable testing is essential before the method can be recommended without qualification.

Craighead (F. C.) & others. **Insect Enemies of eastern Forests.**—*Misc. Publ. U.S. Dep. Agric.* no. 657, 9¼×6 ins., ii+679 pp., 197 figs., 440 refs. Washington [D.C.] 1950. Price $2.50 (from Supt. Documents.)

This handbook is concerned with forests in the eastern United States and is a companion volume to one already noticed [*R.A.E.*, A **26** 400], but is arranged on a different plan. The "enemies" dealt with include not only insects and other Arthropods that are injurious to the trees or to forest products, but also species that are predacious or parasitic on these or on other forms of life, attack man or domestic animals, transmitting disease in some cases, or cause annoyance to persons frequenting forests. The introductory sections include information on the relations of insects to forest and ornamental trees, the

natural factors that affect their abundance, the prevention of infestation, and the methods available for combating insect pests of trees and felled timber. The bulk of the book consists of concise accounts of the appearance, life-history, distribution and, in some cases, control, of the individual species. The latter are arranged systematically, and different authors are responsible for different groups. This part is preceded by keys to the Orders, families and genera of insects injurious to trees, seedlings, etc., and wood products, based on types of injury, and other keys, varying in scope and based primarily on systematic characters, food-plants or damage, are given in the systematic sections.

HOCKING (B.). **On the Effect of crude Benzene Hexachloride on Cereal Seedlings.** —*Sci. Agric.* **30** no. 5 pp. 183–193, 1 pl., 19 refs. Ottawa, 1950.

Crude BHC (benzene hexachloride) has frequently been reported to impair the development of plants from seeds or tubers [*R.A.E.*, A **36** 156 ; **37** 317 ; **38** 3]. As marketed, it contains about 70 per cent. α isomer, about 5 per cent. β isomer, 12 per cent. γ isomer, some δ isomer and small amounts of other materials, but the constituent responsible for the damage is not known. Investigations on this point were begun in 1948, when batches of wheat seed were treated at the end of March with crude BHC containing 10–12 per cent. γ isomer, a proprietary BHC dust containing 6 per cent. γ isomer, and " pure " γ isomer, all at rates of 0·2–1 per cent. γ isomer by weight, with the addition, in the case of the first two materials, of a 2 per cent. solution of methyl cellulose as adhesive. Some of the seeds were set to germinate in pots or on filter paper on 8th April and the rest after two months. All the plants from treated seeds showed browning and swelling of the root tip, shortened roots, absence of root hairs, and a shortened, thickened and flattened coleoptile, but the symptoms were less pronounced in the case of " pure " γ BHC. On 26th May, the root growth of the seedlings was poor for all treatments, but least impaired for " pure " γ BHC at the lowest rate. Seeds harvested from the experimental plants germinated normally. No noticeable difference resulted when the treated seeds were stored for two months. In a similar test, the seeds were treated with the same three materials at rates of 0·2–9 per cent. total BHC by weight, and the early growth of seeds treated with " pure " γ isomer was rather more rapid than that of the others, but no other differences were noted between them. When the seeds were treated with a proprietary mercurial seed dressing containing 40 per cent. γ isomer at the maximum recommended rate (0·2 per cent. γ isomer), they germinated normally, but the resulting seedlings were distorted ; when it was used at twice the recommended rate, germination was also affected.

In a further series of tests, the materials investigated were α and β BHC, a freshly prepared sample of γ BHC (melting point 110–112°C.) and a sample that had deteriorated (m.p. 90–100°C.), and a mixture of trichlorbenzenes prepared from α BHC and containing at least 85 per cent. of the 1,2,4-isomer. Trichlorbenzene and hydrochloric acid are among the breakdown products of BHC. The materials were used at 0·2, 4 and 5 per cent. by weight, the trichlorbenzenes being emulsified in water, and the seeds were set to germinate in petri dishes immediately after treatment, after storage in darkness for 10 or 20 days or after storage for a further ten days in daylight under glass, including exposure to sunlight for a total of 12 hours. Apart from the controls, the only seeds that developed normally were those treated with β BHC. The trichlorbenzenes prevented germination at the higher doses and retarded it at the lowest, though the subsequent development of the seedlings was normal ; α BHC caused slight and fresh γ BHC typical deformities, which in both cases were more severe at the higher dosages ; and stale γ BHC was slightly less injurious than fresh. Exposure to sunlight increased the phytotoxic

effects and the characteristic musty odour of α BHC and both samples of γ BHC. Seeds were then set to germinate in petri dishes in the dark and exposed to the vapours from liberal amounts of fresh or stale γ BHC, the mixture of trichlorbenzenes or hydrochloric acid in watch glasses, each dish and its untreated control being isolated from the others. Hydrochloric acid had no effect. Root length was reduced by 30 and 58 per cent. by fresh and stale γ BHC, respectively, and the latter also retarded germination, but the controls were not affected. The trichlorbenzenes completely inhibited germination, and in this case the controls showed extreme deformation typical of heavy seed treatment with solid γ BHC, evidently because some of the vapour had diffused from under the cover of the treated dish and into the adjacent control dish. When the tests with the trichlorbenzenes were varied by confining the vapour in an airtight container or reducing the amount used to one that would volatilise completely in 24 hours, seeds that received the former treatment failed to germinate and those that received the latter developed typical deformities, but the controls were not affected. The seeds of six varieties of wheat, three of oats and three of barley were then exposed to the vapours from the 1,2,3- and 1,3,5-isomers of trichlorbenzene and the mixture containing 85 per cent. of the 1,2,4-isomer. The seeds exposed to 1,2,4-isomer all failed to germinate. Of those exposed to the 1,2,3-isomer, some of all the varieties germinated, except two of wheat and two of oats, but the seedlings died in eight days. The 1,3,5-isomer greatly retarded growth, but all the varieties germinated and the seedlings were living after 12 days. The differences in varietal susceptibility were not considered sufficiently great to justify breeding experiments. Two other preparations of the 1,2,4-isomer were then tested, and gave similar results to the original mixture. One of these was stated to contain about 95 per cent. 1,2,4-trichlorbenzene, the impurities comprising mostly tetrachlorbenzenes with small amounts of dichlorbenzene, and the other was stated to consist of 1,2,4-trichlorbenzene with 5–10 per cent. of the 1,2,3-isomer, but no free hydrochloric acid and probably no orthodichlorbenzene, paradichlorbenzene or tetrachlor products. Since 2,4-dichlorphenol, a component of the 2,4-D molecule [2,4-dichlorphenoxyacetic acid], has also been included among the breakdown products of BHC, seeds were exposed to the vapour from it. The results were similar to those obtained with 1,2,4-trichlorbenzene.

It is concluded from these results that the injury attributed to BHC is due to the formation of trichlorbenzenes. Under normal conditions, a mixture of the 1,2,4-, 1,2,3- and 1,3,5-isomers appears to be produced in effective proportions and amounts from γ BHC, in threshold amounts from α BHC and in unimportant amounts, if at all, from the other isomers. Seedlings germinated in soil are less severely damaged than those in petri dishes, presumably owing to adsorption of the toxic materials on the soil particles and better ventilation, though the slower rate at which BHC breaks down under such conditions may also be contributary [**37** 411]. The three isomers of trichlorbenzene are probably inherently equal in toxicity, the greater effect of the 1,2,4-isomer being a reflection of its vapour pressure. Trichlorbenzenes themselves possess some insecticidal activity [*cf.* **27** 422].

WELLINGTON (W. G.). **Effects of Radiation on the Temperatures of Insectan Habitats.**—*Sci. Agric.* **30** no. 5 pp. 209–234, 3 figs., 29 refs. Ottawa, 1950.

The effects of meteorological factors on the conditions prevailing within microhabitats of forest insects were studied in the field in Ontario at 46° 30′N. lat. during 1947, and findings with regard to the effect of radiation are here given. The following is almost entirely the author's summary. The observed differences between the temperatures of insects and of the parts of plants on

which they feed, on the one hand, and the temperature of the surrounding air, on the other, are sufficiently large to merit consideration in field studies. The differences observed are largely a result of radiant heating by day and radiant cooling by night. Under winter conditions when the sun is low, heating is still sufficient to raise exposed coniferous foliage more than 2°C. [3·6°F.] above the surrounding air. By night, exposed foliage radiates down as much as 0·8°C. [1·44°F.] below the air temperature under a clear sky. Snow-covered foliage remains above the air temperature on clear, calm nights, and below it during sunny days. This damping of daily fluctuations means that insects overwintering on branches beneath snow cover may experience about 8°C. [14·4°F.] less total change per day than insects on exposed branches. Summer conditions give results somewhat similar to those observed during the winter, but values differ in degree. More intense incoming radiation by day raises vegetative parts as much as 8°C. above surrounding air, and more rapid rates of outgoing radiation at higher night temperature levels lower vegetation temperatures as much as 3°C. [5·4°F.] below the surroundings under a clear sky. Wind does not modify temperatures elevated by radiant heating to a very marked degree, but it affects radiant cooling at night, particularly in winter when the decreased rate of cooling at generally low temperature levels is below that prevalent under summer conditions. Winter cloud by day keeps exposed foliage slightly above air temperature, and by night re-emitted radiation from low cloud raises foliage temperatures fractionally above the air. Summer cloud by day permits elevation of foliage temperatures to 2°C. above the air. At night, an overcast sky seldom maintains foliage temperatures a significant amount above the surrounding air. When isolated clouds obscure the sun, but not the rest of the sky, at any season, foliage radiates to levels below air temperature. Similarly, foliage exposed to the sky, but shielded from the sun, cools by radiation. If broken cloud is present, diffuse radiation keeps such foliage from cooling.

The internal temperatures of larvae of the spruce budworm, *Choristoneura fumiferana*, Clem., in their feeding tunnels in early July varied from 3·6°C. [6·48°F.] below to 8·9°C. [16·02°F.] above air temperatures, and that of the feeding tunnels from 4·7 [8·46°F.] below to 4·6 [8·28°F.] above air temperatures. Different parts of trees differ in their capacities to respond to radiant heating. Staminate flowers of coniferous trees commonly are at temperatures 5–8°C. [9–14·4°F.] above vegetative buds in sunlight. Since the buds, in turn, are above air temperature, this is an important difference for insects with habits like those of *C. fumiferana*. The silken tents constructed by *Malacosoma pluvialis*, Dyar, and *Hyphantria textor*, Harr., trapped air of which the temperature frequently ranged 8–13°C. [14·4–23·4°F.] above that of the outside air in full sunlight.

SPENCER (G. J.). **Notes on some Dermestidae of British Columbia (Coleoptera).** —*Proc. ent. Soc. B.C.* **44** pp. 6–9, 2 refs. Vernon, B.C., 1948.

The author collected 15 species of Dermestids, of which two are unidentified, in the dry belt area of British Columbia over a period of 16 years and gives notes on the occurrence of 11 of them. The only one of much economic importance is *Anthrenus verbasci*, L., which was first recorded in Vancouver in 1936 and has become the most troublesome household pest in the Lower Fraser Valley and the extreme south-west of British Columbia. Fumigation with hydrocyanic acid gas gives only temporary control and is thought not to kill the eggs, since larvae were found in a house only three months after treatment. In May 1947, adults were found out of doors on a white blanket and on flowers, and it is assumed that they feed on white garden flowers and enter houses to oviposit [*cf. R.A.E.*, A **33** 229]. Feeding on pollen or nectar is not, however,

required for the maturation of the eggs, since a culture maintained in a box for 11 years was provided only with crushed Purina Fox Chow biscuits, except for two periods of a few months, when the biscuits were replaced by grains of wheat or oats. The generations overlapped, but adult populations appeared to reach peaks in March–April and in September–November. Adults kept in a tin without food paired and laid many eggs, most of which hatched ; two months later, many active larvae were present and the bodies of most of the original beetles had been eaten, but not the unhatched eggs. Larvae kept without food in a tin of which the floor was dusted with DDT were unaffected at the end of a fortnight and finally died of starvation. Larvae sprayed with 5 per cent. DDT in Varsol (a proprietary cleaning fluid), soon became incapable of movement, but survived until the spray had come in contact with the under surface of their bodies. Larvae confined in a box with a few grains of crude benzene hexachloride died in 48 hours.

Megatoma vespulae, Milliron, infested specimens of insects, birds and mammals at the University of British Columbia from 1931 to 1943, but was then gradually eliminated by spraying the outsides of the cabinets with 5 per cent. DDT in Varsol each year. The Dermestid previously recorded by the author as *Anthrenus scrophulariae*, L., and as a host of *Laelius* sp. [**31** 212] is here stated to be *A. pimpinellae* var. *occidens*, Csy., which is not of importance in houses. *A. scrophulariae* is not known to occur in British Columbia.

DOWNES (W.). **The Control of the Holly Leaf Miner** *Phytomyza ilicis* **Curtis by Means of DDT (Diptera : Phytomyzidae).**—*Proc. ent. Soc. B.C.* **44** p. 14. Vernon, B.C., 1948.

Following promising results in 1945, a large-scale test was made in 1946 of the value of DDT for the control of *Phytomyza ilicis*, Curt., on holly [*Ilex aquifolium* (*cf. R.A.E.*, A **27** 669)] in British Columbia. A powder containing 20 per cent. DDT ground in pyrophyllite was used in sprays at rates giving 2 and 1 lb. actual DDT per 100 gals. water, and 110 gm. Orvus [32 per cent. sodium lauryl sulphate] was added as a spreader, but this amount was too great and the frothing that resulted slowed down the pump and caused excessive run-off. The sprays were applied on 11th May, when the buds were beginning to open on most of the trees and some were in full bloom, and the results were estimated on 26th February 1947, when the mines had reached their maximum size. The percentages of mined leaves were 0·6 and 6·2 for 2 and 1 lb. DDT, respectively, and 61·05 for no treatment. A few adults had been observed at the time of spraying, and since oviposition occurs a few hours after emergence, these early individuals may have been responsible for some of the infestation on the sprayed plots. Pollination was not affected by the DDT. In 1945, bees were seen to fly away after visiting a few flowers on trees treated in full bloom, but as they were in contact with the sprayed surfaces for only a short time it was thought that the DDT would have no toxic effect on them.

MORGAN (C. V. G.). **The Biology of** *Monochamus notatus morgani* **(Coleoptera : Cerambycidae).**—*Proc. ent. Soc. B.C.* **44** pp. 28–30. Vernon, B.C., 1948.

In view of an apparent increase in the populations of bark and timber beetles in the Lumby district of British Columbia, the bionomics of *Monochamus notatus morgani*, Hopping, were studied in Trinity Valley in 1940–44. So far as is known, this Lamiid, the egg and larva of which are described, infests only *Pinus monticola*, and in several trials in which logs of various trees were exposed to females, *P. monticola* was the only species in which eggs were laid. In 1942,

emergence from the logs occurred between 9th July and 10th August and the adults had become scarce in the latter part of September, when they were active only during the warmest periods of sunny days. The last females were seen in a weak condition attempting to oviposit on 1st October. Adults kept under artificial conditions lived for over a month, and one female caged with branches of *P. monticola* survived for 82 days. The beetles were observed to feed only after sunset, when they flew from the oviposition sites to neighbouring trees and fed on the outer bark and phloem of living twigs and branches of *P. monticola*, Douglas fir [*Pseudotsuga taxifolia*], Engelmann spruce [*Picea engelmanni*], western hemlock [*Tsuga heterophylla*] and western red cedar [*Thuja plicata*]. *Pinus monticola* was preferred, and *T. plicata* only occasionally attacked. In the latter part of September, a small amount of feeding by old and weak adults sometimes occurred on logs. When confined on cut logs, the adults fed heavily on the bark.

Weakened trees are known to be preferred for oviposition, and in 1942, at the height of the flight period, eggs were laid in logs felled only two days previously. Males and females were usually seen together at the height of the flight period, and pairing often occurred immediately before and after egg-laying. Males of *M. oregonensis*, Lec., were observed pairing with females of *M. n. morgani* and in attendance on them during oviposition. The eggs were laid singly in slits in the bark in areas exposed to sunlight, and thick bark was preferred. The phloem round the slit turned brown.

The larvae hatched in 9–15 days, depending on weather and exposure to direct sunlight, and made their way to the cambium region where they mined between the bark and the sapwood, scoring the sapwood and separating it from the bark by packing frass and chips between them. Holes for the extrusion of chips were made about two months after the eggs were laid, and at the same time the larvae began to bore into the sapwood, penetrating to depths of up to 2 ins. during the first autumn. Of 23 larvae, eight had entered the sapwood by mid-September. Feeding continued through the following year, and by the second spring U-shaped tunnels had been formed and the larvae were nearly full-grown. Pupation occurs in a chamber at the end of the gallery, which is described. The prepupal stage was apparently very short and the pupal stage lasted about a month, the first pupa being observed on 5th June and the first adults in early July.

M. n. morgani was parasitised by an Ichneumonid thought to belong to the genus *Ichneumon* and a Braconid, *Doryctes* sp., was found in the larval galleries. An attempt to rear a Dipterous larva taken from a gallery containing a partially destroyed larva of *M. n. morgani* was unsuccessful. The Lamiid appeared fairly free from disease, only two dead adults showing symptoms being found in their pupal cells over a period of two years.

ALBERTS (H. W.). **Quinoa—ancient Food Crop in South America.**—*Agric. in the Amer.* **7** no. 12 pp. 150–152, 4 figs. Washington, D.C., 1947.

Quinoa (*Chenopodium quinoa*) was formerly an important food crop among the Indians of Andean America, but is now cultivated only on a small scale in Peru. The method of cultivation and uses of the crop for food and fodder are described. It is occasionally damaged by insects, including the cutworms, *Laphygma frugiperda*, S. & A., *L.* (*Xylomyges*) *eridania*, Cram., *Feltia experta*, Wlk., and *Lycophotia interrupta*, Maassen, which attack the seedlings soon after germination, larvae of *Psara* (*Pachyzancla*) *bipunctalis*, F., and *Hymenia recurvalis*, F. (*Zinckenia fascialis*, Stoll), which web the leaves and inflorescences together and feed on them, and adults of *Epicauta latitarsis*, Haag, and *E. willei*, Denier, which feed voraciously on the plants during January–March and sometimes destroy a whole crop.

Rivnay (E.). **Biology of *Gynaikothrips ficorum* Marsh. in Palestine (Thysanoptera).**—*Bull. Soc. Fouad Ier Ent.* **31** pp. 129–140, 3 figs., 3 refs. Cairo, 1947.

Gynaikothrips ficorum, Marchal, which feeds on the leaves of the ornamental *Ficus nitida*, causing them to roll [*R.A.E.*, A **34** 18, 19 ; **35** 152], was observed in Palestine for the first time in 1943 and was reported from widely separated parts of the country in the following year. Studies of its bionomics were made in the laboratory and also, since cut leaves and the leaves of plants in pots grow too slowly to fold, on infested trees. It was found that mated females feed on the very young leaves for a few days before ovipositing, and several females with their progeny often occur together in one folded leaf. The egg stage lasted about a week in summer and about three in winter, the nymphal stage eight days at 26·5°C. [79·7°F.] and 10–11 days at 22·5°C. [72·5°F.], the prepupal stage about one day at favourable temperatures, and rarely more than three in January–March, and the two pupal instars 3–6 days in March and as many as ten at lower temperatures. The young adults do not emerge from the folded leaves for a few days and those of the overwintering generation remain in them throughout the winter. There was a preoviposition period of 6–7 days at 23°C. [73·4°F.]. The maximum number of eggs found in a leaf containing only one female was 125, but the average numbers deposited by mated females isolated in May and July–August were 88 and 26. Complete development required 20–37 days at temperatures of 26·4–21·5°C. [79·52–70·7°F.], and there were estimated to be eight generations a year in the coastal plains, with one more if the winter is exceptionally mild. Activity is usually low in winter, and increases in spring with the development of new leaves on the plant. The numbers of newly-infested leaves and of eggs and nymphs increase steadily during spring and early autumn and decrease during the summer and in November–December. Some of the reduction at midsummer may be due to heat, but much of it is caused by a predacious Anthocorid, *Ectemnus* sp., which is scarce in winter and then increases until over 90 per cent. of the folded leaves show evidence of its presence by midsummer. After this its numbers fall, but they rise in autumn when the thrips has again become abundant. Its eggs are deposited under the epidermis inside the rolled leaves, and the nymphs feed on the eggs and nymphs of *Gynaikothrips* ; nymphal development lasts about 12 days during August.

Microscopic examination showed that the folding of the leaves is caused by hypertrophy of the parenchyma where the thrips feed ; continued feeding causes the formation of a depression and the enlargement of the individual cells of the adjacent tissue, and sometimes necrosis of the parenchyma in the immediate vicinity. Newly folded leaves turn pink and later become brownish, owing to the presence of an anthocyanin.

In experiments on control in which sprays were applied by means of high-power equipment at a pressure of about 500 lb., oil emulsions at concentrations of up to 1·5 per cent. were ineffective, but 0·1 per cent. nicotine (as nicotine sulphate) with 0·03 per cent. sodium lauryl sulphate, alone or with white oil, killed all the thrips in about 60 per cent. of the folded leaves in two days. Nicotine without the sodium lauryl sulphate did not penetrate the folded leaves, and mortality was very low when a hand sprayer was used.

Hassan (A. S.). **The Beanfly *Agromyza phaseoli* Coq. in Egypt (Diptera : Agromyzidae).**—*Bull. Soc. Fouad Ier Ent.* **31** pp. 217–224, 8 figs., 9 refs. Cairo, 1947.

Losses of bean plants reported from different parts of Egypt in the autumn of 1939 were found to be caused by *Agromyza phaseoli*, Coq., the bionomics and control of which were accordingly investigated. Of the two crops of french

beans grown each year, infestation was heavy on that sown in August–October and apparently absent from that sown in February–March. In autumn, the plants were attacked as soon as they appeared above ground, and as many as 25 larvae and pupae were found in dead plants 8 ins. high. Some plants were killed by the presence of 10–15 larvae, but plants that formed adventitious roots sometimes recovered, and the yield was then not affected. Observations on the bionomics of the fly and the manner of infestation confirmed those of W. L. Morgan [*R.A.E.*, A **26** 335]. Seedling cowpeas received in April 1941, when they were 13 days old, contained a few eggs and larvae, and larvae were found in cowpeas and lima beans in September. These or other leguminous plants probably carry the infestation through the summer. Two parasites reared were identified as *Trigonogastra agromyzae*, Dodd, and *Eurytoma larvicola*, Gir. Both were most active in September–December.

Tests were made in the autumn of 1941 with mixtures of white oil and nicotine sulphate, similar to those recommended by Morgan [*loc. cit.*]. The most satisfactory treatment, taking economic considerations into account, was to apply a spray containing 1·5 per cent. white oil and 0·2 per cent. nicotine sulphate four times at weekly intervals, beginning four days after germination. More numerous applications made at intervals of four days gave better control, but the expense was high. The development of adventitious roots can be facilitated by earthing up the plants. Some indications of varietal resistance was obtained among 38 varieties of beans tested.

HAFEZ (M.). **The Biology and Life-history of** *Apanteles ruficrus* **Hal. (Hymenoptera-Braconidae).**—*Bull. Soc. Fouad Ier Ent.* **31** pp. 225–249, 9 figs., 14 refs. Cairo, 1947.

An account is given of investigations on the bionomics of *Apanteles ruficrus*, Hal., in Egypt where this Braconid is widespread and second in importance only to the Tachinid, *Gonia capitata*, Deg., as a parasite of *Agrotis ypsilon*, Hfn., together with a summary of its world distribution and descriptions of all stages and the reproductive organs of both sexes. In the course of the work, it was reared in numbers from field collections of *A. ypsilon*, *A. spinifera*, Hb., *Autographa* (*Plusia*) *gamma*, L., *A.* (*P.*) *circumflexa*, L., *Leucania loreyi*, Dup., *Sesamia cretica*, Led., and *Laphygma exigua*, Hb. It was not reared from *Prodenia litura*, F. [*cf. R.A.E.*, A **25** 336], and larvae of this species in which females oviposited in the laboratory survived for only five days. Larvae of *Agrotis ypsilon* and *L. exigua* were the most convenient hosts for laboratory rearings ; the methods adopted for breeding hosts and parasites are briefly described.

Larvae of *A. ypsilon* were attacked in all instars except the sixth ; eggs were rarely laid in fifth-instar larvae, and larvae parasitised in the first or second instar usually died in a day or two. The parasite larvae feed on the body fluids and fat-body of the host and emerge from it to pupate in cocoons, which they construct in masses close to it. The numbers of larvae that emerged from individual hosts in the field averaged 63. The host larva dies about 24 hours after the parasite larvae have left it. The egg, larval, prepupal and pupal stages lasted five days, nine days, about four hours, and five days, respectively, in the laboratory at 26·5°C. [79·7°F.], and complete development under field conditions required a minimum of 20 days in June at 27°C. [80·6°F.] and a maximum of 61 days in January–February at 12·3°C. [about 54°F.]. All the adults from a single cocoon-mass emerged within 24 hours ; males were in general twice as numerous as females, but only males were obtained from a few cocoon masses and only females from one. The percentage of cocoons from which adults emerged decreased from 97·1 in February to 44·3 in June. Mating and oviposition occur within three hours of emergence ; unmated

females produce male offspring. Insertion of the ovipositor in the host was not always followed by oviposition, but the females were not observed to imbibe the body fluids of the host. The deposition of eggs in a host by one female induced others to oviposit in it. On the average, a female deposited 26 eggs with each insertion of the ovipositor, parasitised five larvae and produced 216 progeny. When provided with honey and water, females lived for averages of 17·5 and 3 days under field conditions at 12·1 and 19·2°C. [53·78 and 66·56°F.], respectively, and 43 days when kept at 12·8°C. [55·04°F.], with a period of three hours each day at 16°C. for normal feeding. The corresponding averages for males were 12·5, 1·7 and 41 days.

Adults of the winter generation emerge in March, when *A. ypsilon* is most abundant, and the parasite cocoons reach peak numbers in April–May. At this season, *Laphygma* and *Autographa* are also attacked. During the summer, the main hosts are *Laphygma* on cotton and maize and *Sesamia* on maize. In October, when populations of *Sesamia* begin to decrease and those of *Agrotis* to increase, the latter again becomes the most important host.

Natural enemies of the parasite include birds and ants that feed on the fully grown larvae and pupae, and a Pteromalid hyperparasite that emerged from a very small percentage of the field-collected cocoons. *Apanteles* was found to offer considerable control of *Agrotis ypsilon*, especially on clover, in March–May, when parasitism varied between 10 and 25 per cent. and reached 50 per cent. in some samples. No parasites were reared in July and August, but 5 per cent. of the larvae of *Agrotis* were parasitised in October and 2–4 per cent. during December–February. *A. ruficrus* is more important than *Gonia capitata* in spring and early summer, but less so in winter.

HANNA (A. D.). **Studies on the Mediterranean Fruit-fly *Ceratitis capitata* Wied. (Diptera Trypaneidae). II. Biology and Control.**—*Bull. Soc. Fouad Ier Ent.* **31** pp. 251–285, 3 col. pls., 49 figs., 36 refs. Cairo, 1947.

Ceratitis capitata, Wied., usually infests practically all the fruits of apricot and peach in Egypt, so that their cultivation has greatly declined in recent years. This paper, which is the second of a series [*R.A.E.*, A **27** 512], comprises an account of several years' investigations concerned primarily with its control ; it includes descriptions of the immature stages, the internal anatomy of the larvae, the mouth-parts, alimentary canal, eyes and olfactory organs of the adults, and the symptoms of infestation in fruits of peach, *Citrus* and mango. During 1940–45, the percentage infestation of *Citrus* fruits varied from 0 on bitter orange, lemon and Egyptian lime to 5 on common Egyptian tangerine between August and February and was 18 on summer oranges. Of other fruits, guavas are infested moderately and plums very slightly. The adult population in a mixed orchard was greatest in July, when peaches became ripe, and then decreased until October, when there was a rise corresponding with the ripening of *Citrus* fruits. Eggs are laid in cells in the pith of *Citrus* fruits and in the pulp of stone fruits. The average number per cell was 22, with a maximum of 78 in tangerine. Most were deposited in the lower halves of *Citrus* fruits and near the stem end in stone fruits. The durations of the egg, larval and pupal stages ranged from 2, 9 and 8 days, respectively, in June–August, when the temperature was 26–27°C. [78·8–80·6°F.], to 6, 30 and 30 days in March, when it was 16°C. [60·8°F.]. Females fed only on cane-sugar solution laid an average of 16 eggs each and lived for an average of 11·5 days, including a pre-oviposition period of 8·5 days. When a little protein was added to the solution, the average number of eggs laid increased to about 280 and the average survival period to about 32 days, with a pre-oviposition period of only four days. Females fed exclusively on egg protein in water survived for about a week and did not oviposit. Males fed on sugar, protein or both all

became sexually mature in about four days, but those fed only on protein all died in a week. Experiments on the movements of flies in glass jars indicated that they are attracted by light in cool weather but seek shade in hot sunny weather. The Malpighian tubes of flies caught in the field contained considerable numbers of granules of calcium carbonate ; such granules were not often found in flies fed on fresh cane-sugar solution, but developed when the solution fermented or organic acids were added to it. It is concluded that flies in the field feed on fallen fruits which, in addition to organic acids, contain the protein and sugar necessary for egg formation. Analysis of mature fallen fruits in a mixed *Citrus* orchard in December showed them to consist of 5·7 per cent. sugar, 0·5 per cent. protein, 10 per cent. organic acids and 83·8 per cent. water.

Poisoned baits for the adults were considered to offer the best promise of control, and experiments were made to find a suitable bait, poison and method of exposure. Numerous bait mixtures were tested until one was found having a composition similar to that of the fallen *Citrus* fruits ; it consisted of a mixture of 2 gals. molasses containing 55 per cent. sugar and 8 lb. fine wheat bran (or 1 lb. casein) in 20 gals. water fermented for 12 hours in summer or 16 hours in winter. The best of some 70 inorganic poisons tested in baits in the laboratory were barium chloride, the tartrates of antimony and potassium, sodium nitrite, sodium fluoride, sodium arsenate and sodium arsenite, which were about equally toxic in sugar solution, a concentration of 2 per cent. killing the flies in 24 hours ; flies fed on a bait containing sodium fluosilicate, which is less soluble in water, required 2–3 days to accumulate a lethal dose. In tests to determine the best method of exposing the bait, receptacles of different materials and shapes filled with it, bundles or mats made of the stems or leaves of maize, *Typha angustata* or rush (*Juncus*) dipped in it, and seaweed soaked in it were suspended from the trees. Bundles of *Typha* were the most effective, one 14 ins. long and 6 ins. in diameter absorbing about a pint of the bait and retaining most of it for 4–5 days in the hottest season. In ten trials at various places in 1940–45, in which such bundles were hung on peach or apricot trees, from 68 to 99·7 per cent. of the fruits were free from infestation, as compared with from 0 to 70 per cent. on the control trees ; the corresponding percentages in a single test on *Citrus* were 99·8 and 95. A bait made with molasses that contained as much sugar but tasted bitter was less effective. The bundles were suspended about half way up the trees, since experiments showed that populations were highest there, and in the shade ; on *Citrus* trees, where the baits are used in winter, they should be suspended in the sun. In a consideration of the cost of using the bran-molasses mixture with 2 per cent. poison on various kinds of fruit, it is stated that sodium arsenite, sodium arsenate, barium chloride and sodium fluoride are the least expensive poisons in the order given, but the first two scorch the leaves, and if their use is unavoidable, the bundles should first be stood on end to permit excess liquid to drain off. The bundles should be hung on peach trees from mid-May until mid-July, on apricots from mid-April till the end of May, and on guava from mid-July until mid-September ; they should be dipped in fresh bait every six days. On *Citrus*, they should be on the trees during October–November and dipped every 15 days.

Brown (E. S.). **The Distribution and Vegetation of Egg-laying Sites of the Desert Locust** (*Schistocerca gregaria* **Forsk.) in Tripolitania in 1946.**—*Bull. Soc. Fouad Ier Ent.* **31** pp. 287–306, 4 pls., 2 maps, 3 fldg. tables, 4 refs. Cairo, 1947.

Swarms of *Schistocerca gregaria*, Forsk., sometimes reach Tripolitania (Libya) in outbreak years, and the subsequent breeding is then of economic importance in the cultivated coastal areas. In this paper, the author describes

investigations on the egg-sites, made in early 1946 in the course of control operations. The following is largely his summary. An account is given of the vegetation and other features of 16 egg-laying sites considered typical of northern Tripolitania. Annual plants predominate in the flora of these sites and are typical of recently colonised sand-dunes undergoing reclamation. The Papilionaceae, Compositae and Gramineae are the dominant families. Egg-laying sites are distributed mainly along the edge of cultivation, on fixed sand-dunes in process of reclamation rather than on cultivated ground. The operation of reclamation appears to create the conditions of soil and vegetation that are most favourable for oviposition. Intensive reclamation has been in progress for about 30 years, and may have resulted in the concentration of favourable conditions round cultivated tracts, so that when locusts enter the territory, they lay their eggs where the resulting hoppers may do most damage. Observations on feeding indicate that hoppers exercise a marked selection of certain annual and perennial plants that predominate in the egg-laying sites.

The concentration of egg-laying round cultivated areas makes the control of hoppers difficult, particularly since young hoppers appear to feed on the annual plants in preference to bait. In a preliminary test in April 1946, sprays of suspensions of benzene hexachloride in water gave up to 75 per cent. control in one day, depending on the concentration, and were greatly superior to the standard bait. The sprayed vegetation remained toxic to the hoppers for at least six days, and the cumulative mortality over the whole period must have been very high. Although baiting should remain the standard method of attack, it is suggested that control might be supplemented by spraying selected food-plants.

Hussein (M.). **Further Tests on the Use of crude Benzene Hexachloride and DDT against Locusts and Grasshoppers.**—*Bull. Soc. Fouad Ier Ent.* **31** pp. 313–320, 2 graphs, 1 ref. Cairo, 1947.

Crude BHC (benzene hexachloride containing 13 per cent. γ isomer) and DDT were tested against *Euprepocnemis plorans*, Charp., in Egypt in 1947. Proprietary powders containing the insecticides were used and compared with sodium arsenite containing 78 per cent. arsenic trioxide. In tests with baits against adults in the laboratory, 0·6 per cent. BHC gave complete mortality in 48 hours, and 3 per cent. sodium arsenite did so in 72 hours, but 0·075 per cent. DDT killed only 45 per cent. in the latter period. When adults in cages were dusted with the powders in rock phosphate, 0·5 per cent. DDT gave 50 per cent. mortality in 72 hours and 4 per cent. BHC gave complete mortality in 48 hours ; the toxicity of a sample of BHC powder that had been kept in the open for a year was reduced. The grasshoppers died more quickly when they were left in the treated cages than when they were transferred to clean ones after 15 minutes, but ultimate mortality was the same. Most of them made little attempt to feed.

BHC was further tested against *E. plorans* in plantations of rice, clover, cotton and maize and in barren areas in the northern provinces of Lower Egypt, where the grasshopper appears each year from May to November in varying numbers. A bait containing 0·6 per cent. BHC gave 50–90 per cent. mortality in 24 hours, depending on atmospheric conditions, time of application, and the kind and height of the crops to which it was applied. A suspension spray containing 2 per cent. BHC gave complete mortality in 24 hours, but the method was costly and slow. A 4 per cent. dust showed promise, and mortality in samples of *E. plorans* collected from fields 15–30 minutes after dusting reached 80–100 per cent. in 24 hours. A high rate of application was needed, varying from about 44 to about 88 lb. per acre, according to the nature

of the area, kind and growth of the vegetation, and the density and distribution of the grasshoppers, and it was also necessary for the poison to come in actual contact with them. The effectiveness of dusting varied with the wind, especially when power equipment was used. Plants in flooded rice-fields began to wilt a few days after the application of the dust.

Following preliminary tests of the effectiveness of BHC against *Schistocerca gregaria*, Forsk., in Egypt [*R.A.E.*, A **36** 412], baits containing 0·4 and 0·6 per cent. BHC were used during the control campaigns against this locust in Arabia in 1946 and 1947. The hoppers began to die 1–4 hours after application, and mortality was in general complete within 24 hours, though when BHC that had been stored in the open for about nine months was used, it did not exceed 50–60 per cent. No cases of poisoning among domestic animals were recorded. Hoppers affected by BHC did not seek shelter, as those poisoned by sodium arsenite do, and were eaten by fresh bands of hoppers entering the area, which succumbed in consequence.

In further tests of the toxicity of BHC to domestic animals [*cf.* **36** 413], two of five goats fed on a mixture of barley and bran (1 : 2) to which 1 per cent. BHC was added died in 25 and 34 days, after showing symptoms of weakness and paralysis of the limbs. Two of six others that received 20 lb. green fodder that had been dusted with 10 gm. BHC died after six and 32 days ; all the animals lost weight.

MILLER (L. W.). **Insect Pests of Cabbages, Cauliflowers, and related Plants.**—*Tasm. J. Agric.* **20** no. 1 pp. 12–16, 6 figs., 1 ref. Hobart, 1949.

The bionomics of *Brevicoryne brassicae*, L., *Plutella maculipennis*, Curt., and *Pieris rapae*, L., on crucifers in Tasmania are briefly reviewed and notes are given on their control by insecticides on vegetable crops. *B. brassicae* is in general less injurious than the caterpillars. Control by biological means is desirable, since cruciferous forage crops are cultivated by many dairy and sheep farmers and are not treated with insecticides. *Angitia cerophaga*, Grav., and *Thyraeella* (*Diadromus*) *collaris*, Grav., which parasitise the larvae and pupae, respectively, of *Plutella*, have been introduced from New Zealand, reared in the laboratory and liberated in several areas, and *Pteromalus puparum*, L., the pupal parasite of *Pieris* introduced in 1942 [*R.A.E.*, A **36** 70] was found to be abundant throughout Tasmania in 1945.

MILLER (L. W.). **The Green Beetle—a Pest of Berry Fruits.**—*Tasm. J. Agric.* **20** no. 2 pp. 106–108, 4 refs. Hobart, 1949.

The Melolonthid, *Diphucephala colaspidoides*, Gylh., occurs throughout south-eastern Australia and Tasmania, but its life-history is unknown. In southern Tasmania, the adults are present from early December to mid-January, when in addition to the foliage of wattles [*Acacia*] and other native shrubs, they feed in swarms on the leaves of fruit trees, bush fruits and strawberries. They cause serious injury to raspberries, loganberries and currants, sometimes completely defoliating the plants, but infestation is sporadic and usually limited to a few plants at any one time. The larvae have been recorded as injurious to grasses, but it is doubtful whether this is correct, and to the roots of strawberries [*R.A.E.*, A **21** 554], though there is no evidence of this in Tasmania or of emergence of adults from strawberry beds. Evans stated that the larvae feed on the roots of *Acacia* and other trees [**28** 46] but modified this statement in a later work [**32** 105]. The movements of the adults suggest that the larvae develop in uncleared bushland, and since berry fruits are mostly grown near such areas, this would account for the seriousness of the damage to them.

The adults on apple and pear are usually killed by the residues from sprays applied against the codling moth [*Cydia pomonella*, L.] ; on plums and cherries, they can be controlled by a spray of 3 lb. lead arsenate in 100 gals. water. Infestation on berry fruits usually occurs when the crops are ripening, and a spray of lead arsenate would leave too much visible residue. In 1945–46, therefore, heavily infested loganberries and black currants at one place and raspberries at another were sprayed with 0·1 per cent. DDT as an emulsified solution. This paralysed the beetles and caused them to fall off the bushes, though many of them did not die for over 24 hours. The treated plots remained free from attack for some weeks, while neighbouring untreated plants were heavily infested. Tests in which sprayed raspberry leaves were picked at intervals and placed in cages with large numbers of beetles showed that even a month after treatment, during which period considerable rain had fallen, the DDT residue gave complete mortality in 36 hours. The residue was not visible, and although fruit was eaten three days after treatment without ill effects, applications within 2–3 weeks of harvest are considered inadvisable. The spray should be applied as soon as the beetles appear, and as they tend to congregate on the upper portions of raspberry canes, it may not be necessary to wet the whole plant.

HARRIS (W. B.). **Control of Woolly Aphis. Trial of H.E.T.P. and E.605.**—*J. Dep. Agric. S. Aust.* **52** no. 12 p. 597. Adelaide, 1949.

HETP (hexaethyl tetraphosphate) and parathion (E 605) were compared with nicotine sulphate against *Eriosoma lanigerum*, Hsm., on 14 small heavily infested apple trees in South Australia. The sprays were applied at a pressure of about 400 lb., and the percentages of colonies that survived treatment were estimated 15 days later. Colonies counted as surviving usually contained 10–50 per cent. living Aphids and appeared likely to develop vigorously. The percentages of colonies surviving averaged 31·9, 21·7 and 30·2 for 1 pint HETP in 150, 100 and 75 gals., respectively, 17·9, 14·4 and 4·3 for 0·005, 0·01 and 0·015 per cent. parathion, and 2·2 for 1 pint nicotine sulphate and 1 gal. white oil per 100 gals. A wetter (Agral III) was used with HETP and parathion. The poor results given by the strongest HETP spray are attributed to decomposition of the insecticide in the spray tank.

PASFIELD (G.). **Use of DDT for Thrips on Tomatoes in the Metropolitan Area. Effect on Incidence of Spotted Wilt.**—*Agric. Gaz. N.S.W.* **59** pt. 11 pp. 604–605. Sydney, 1948.

In view of promising results given by BHC (benzene hexachloride) and DDT against various pests, including thrips, on tomato in the coastal areas of New South Wales [*cf. R.A.E.*, A **37** 41], their effectiveness inland was tested at Wentworthville, a district in the Federal Capital Territory in which spotted wilt, transmitted by *Thrips tabaci*, Lind., is very prevalent on tomato. Early tomatos planted out on 15th October 1947 were treated three times a week, beginning on 20th October, with sprays containing 0·1 per cent. DDT as a wettable-powder suspension or emulsified solution in solvent naphtha, and with dusts containing 2 per cent. BHC (13 per cent. γ isomer) or DDT in kaolin, but the dusts caused such severe injury to the foliage that their use was abandoned after ten days. *T. tabaci* was the only pest that became numerous ; it was also abundant on cabbage, potato and weeds. It was much less numerous on the treated than the untreated tomatos, and the percentages of plants that became infected with spotted wilt were 7·5 for the emulsion and 32·5 for the suspension, as compared with 75 for no treatment. Rainfall, which reduces

the numbers of thrips, was continuous and heavy, so that the rate of infection may have been somewhat less than normal. It reached two peaks, in the second weeks of November and December, respectively.

The emulsion left an even deposit on the leaves, while the suspension hardened the foliage and retarded the growth of the plants, and deposits from it tended to collect at the ends of the leaves. Tomatos from plants treated with the emulsion had a DDT residue of 5·5 parts per million when harvested.

Smith (J. H.) & Weddell (J. A.). **Banana Rust Thrips Control Experiment, 1948.**—*Qd agric. J.* **68** pt. 2 pp. 82–85 ; also as *Adv. Leafl. Dep. Agric. Qd* no. 150, 4 pp. Brisbane, 1949.

In 1946–47, a 2 per cent. DDT dust gave adequate control of *Scirtothrips signipennis*, Bagn., on bananas in Queensland [*cf. R.A.E.*, A **36** 306], and in 1947–48 its effectiveness was compared with that of dusts containing 4 per cent. BHC [benzene hexachloride] or a mixture of 1 per cent. DDT and 1·5 per cent. BHC. Four applications at fortnightly intervals were made to bunches produced between the first week in January and the end of March in four widely separated, moderately infested districts. Injury to the treated bunches was assessed before they reached commercial maturity. All the dusts gave satisfactory control, and while the BHC was most effective against *S. signipennis*, owing to its fumigant properties, which were thought to assist in the eradication of the thrips from the protected top hands, the DDT, alone or in the mixture, also controlled *Heliothis armigera*, Hb., which caused some damage to the fruit on plots treated with BHC and the untreated plots.

In a subsidiary test, the 2 per cent. DDT dust was applied to newly-produced bunches immediately before they were covered with hessian [*cf.* **26** 211] and again a fortnight later, under the covers. The results were good, though somewhat inferior to those on uncovered bunches, and this was thought to be due to the failure of the dust to reach the upper hands. BHC, which has a fumigant effect, would probably be more satisfactory.

S. signipennis prefers to shelter among closely packed fruits and was found to cause more damage to the Cavendish variety, in which the fruits are tightly pressed together when produced, than to Mons Maria, in which they are initially well spaced but close up 2–3 weeks later. The height to which the latter grows, however, renders treatment difficult, especially of the valuable upper hands of fruits, so that the dwarf types of Cavendish may still be preferable to grow.

Australia. **Amendments of the Quarantine (Plants) Regulations.**—*Statutory Rules* 1950 no. 27, 4 pp. Canberra, 1950.

The new regulations in this amendment include two in which insect pests are mentioned. One of them places restrictions on the import of potatoes into Australia and includes a provision that potatoes shall not be imported unless they were grown in an area free from *Leptinotarsa decemlineata*, Say, and were individually found to be free from insects immediately before export. The other prohibits the importation of plants or parts of plants of 17 specified genera of the natural orders Amaryllidaceae, Liliaceae and Iridaceae except under permit. The plants are to be accompanied by a certificate issued in the country of origin stating that they were grown in an area free from *Merodon equestris*, F., *Eumerus strigatus*, Fall., and *E. tuberculatus*, Rond., or that they have been subjected under supervision to specified treatments before shipment. The treatments comprise fumigation with methyl bromide at 3 lb. per 1,000 cu. ft. space for four hours at 70°F. or with hydrocyanic acid gas at 18 oz. per 1,000 cu. ft. for 24 hours at a temperature between 60 and 65°F., or hot-water or vapour-heat treatment in which the temperature is raised to 110°F., and maintained at that level for not less than 1½ hours.

Welsh (J. H.) & Gordon (H. T.). **The Mode of Action of certain Insecticides on the Arthropod Nerve Axon.**—*J. cell. comp. Physiol.* **30** no. 2 pp. 147–171, 6 figs., 34 refs. Philadelphia, Pa., 1947.

The following is the authors' summary. Decapod Crustacea are suitable for studies on the mode of action of insecticides. They show symptoms similar to those shown by insects, they are more susceptible than insects to such poisons as DDT and pyrethrins, and they are of convenient size. The action of insecticides on single motor nerve fibres may be studied in chela and walking-leg, nerve-muscle preparations from Crustacea. Pyrethrins, paradichlorbenzene, naphthalene, nicotine, DDT, many DDT-analogues, and other substances having a high lipid/water solubility ratio, all have a similar action on many nerve axons in Crustacea and insects. They cause a characteristic "multiplication" of nerve impulses ; a brief electric shock to the nerve gives rise to a "train" of many impulses, instead of a single impulse. This volley of impulses causes a tetanic contraction of the muscle innervated by the axon. The impulse "trains" initiated by brief stimuli are of longer duration, the higher the concentration of toxic substance applied to the nerve, and may continue as long as 30 seconds. The impulse frequency is initially high, and declines in a gradual, regular manner to $\frac{1}{2}$ or $\frac{1}{3}$ the initial frequency, and then ceases abruptly. In severely poisoned nerve, "trains" of impulses arise spontaneously in the poisoned nerve and recur at intervals of about 5 to 15 seconds, in a regular rhythm that often persists for hours. The fact that insecticides of diverse chemical structure, many of them extremely stable, have a similar action suggests that the primary action is physical, not chemical. Several lines of evidence indicate that this action is a physical interference at the lipid surface of the axon.

West (T. F.) & Campbell (G. A.). **DDT and newer persistent Insecticides.**—2nd edn. revd., $8\frac{3}{4}\times5\frac{1}{2}$ ins., xiv[+1]+632 pp., frontis., 13 pls., 2 graphs, many refs. London, Chapman & Hall, Ltd., 1950. Price £2 10*s*.

This second edition of the authors' review of the nature and uses of DDT has been considerably expanded to include work subsequent to that noticed in the first [*R.A.E.*, A **34** 327], and a section (pp. 501–568) on some of the newer chlorinated-hydrocarbon insecticides has been added. Both sections cover the literature published up to the end of 1946 and a very few papers published in 1947, but a classified bibliography of additional references up to the end of 1948 is given as an appendix. The new section contains a review of the discovery of the insecticidal properties of benzene hexachloride, its chemistry, methods of preparing it, the forms in which it can be applied against insects, its toxicity to mammals, and work in different countries on its use against Arthropod pests of medical and veterinary importance and pests of plants and stored products, together with shorter reviews of work on the discovery, chemistry and uses of chlordan, and the preliminary results obtained with toxaphene, DDD (dichlordiphenyldichlorethane) and a few other halogenated hydrocarbons.

Kemper (H.). **Die Haus- und Gesundheitsschädlinge und ihre Bekämpfung. Ein Lehr- und Nachschlagebuch für den Schädlingsbekämpfer.** [Pests of household and medical Importance and their Control. A Reference Book for Pest Control Operators.]—2nd edn., $9\frac{3}{4}\times7$ ins., xi+344 pp., 242 figs., 2 pp. refs. Berlin, Duncker & Humblot, 1950. Price 18 *DM*.

This handbook was compiled chiefly for pest control operators in Germany and deals largely with the identity, habits and control of the pests, mostly insects, that they are likely to encounter in buildings as destructive to fabric, furniture, clothing or stored products, harmful to human health or merely a

nuisance. The emphasis throughout is on practical considerations. The introductory chapters contain discussions of the duties of pest control operators, the knowledge they should possess and the economic and hygienic importance of various types of pests. Accounts are then given of the zoological classification of pests, the morphology of Arthropods and the various ways in which pests are dependent on external conditions, followed by a list of the principal domestic pests arranged according to their environment, their food habits or the traces they leave behind. The two main chapters contain information on the appearance, bionomics, importance and control of individual pests, or groups of pests, arranged systematically, and the methods available for the prevention and control of various types of infestations, with a review of insecticides, their modes of action and methods of application. A summary of German legal provisions regulating the sale and use of poisons is appended.

Statens Skadedyrlaboratorium. Årsberetning 1948–1949. [Danish National Pest Infestation Laboratory. Annual Report 1948–49.]—26 pp. Springforbi, 1949. (With Summaries in English.)

The Danish National Pest Infestation Laboratory, which had existed as a private institution for some years, was taken over by the Danish Ministry of Agriculture in June 1948. This is its first official annual report. It is divided into several sections, of which the first is noticed elsewhere [*R.A.E.*, B **38** 196]. The second is the annual report of the Grain Pests Committee, which was set up at the suggestion of the Laboratory, and deals with advisory work and propaganda for farmers. Of the grain stores inspected during the year, 29 per cent. were infested by pests, and one fourth of the infestations found were due to the presence of *Tribolium* spp. in imported pollards and middlings. *Tinea granella*, L., *T. infimella*, H.-S. (*personella*, Pierce & Metcalfe) and *Endrosis sarcitrella*, L., had become scarce, probably owing to climatic conditions. The next section contains the preliminary results of a survey of the distribution of stored grain pests in Denmark, and the last comprises an account by F. S. Andersen of investigations on the bionomics of *E. sarcitrella*. The newly hatched larvae were shown to prefer damp grain, but those about to pupate sought a drier environment and spun much webbing. A culture of the moth was set up in jars with barley kept moist by a special device as the food. The life-cycle lasted 2–4 months at 20–25°C. [68–77°F.] and development was not completed at relative humidities of less than 80 per cent.

Palm (T.). **Ett angrepp av** *Dendroctonus micans* **Kugel på tall (Col. Scolytidae).** [An Attack by *D. micans* on Pine.]—*Ent. Tidskr.* **69** pt. 4 pp. 212–214, 1 fig. Stockholm, 1948.

Dendroctonus micans, Kug., normally attacks fir [*Abies*], but in May 1948 it was observed in association with *Pissodes pini*, L., in a pine tree at Billtjärn in Sweden, near a few infested firs, and two dead pines showing signs of old infestations were also found. The pine tree had apparently been first attacked by *D. micans*, larvae were found in considerable numbers, and larvae and adults of *Rhizophagus grandis*, Gylh., which is predacious on *D. micans*, were also present.

Borg (Å.). **Om en övervintring av** *Pyrausta nubilalis* **Hb. i Skåne.** [The Overwintering of *P. nubilalis* in Skåne.]—*Ent. Tidskr.* **70** pt. 4 pp. 270–271, 1 fig. Stockholm, 1949.

Following the discovery of *Pyrausta nubilalis*, Hb., on hops in southern Sweden in 1947 [*cf. R.A.E.*, A **37** 456], larvae that had entered hibernation in the dried hop stems in the autumn were kept over winter in an insectary.

They were all alive in the following March but did not feed, pupae were observed from 9th June, and adults emerged from 8th July.

Heqvist (K.-J.). **Några iakttagelser över tallmätarens parasiter under senaste härjningen i södra och mellersta Sverige (1943–1945).** [Observations on the Parasites of *Bupalus piniarius*, L., during the last Outbreak in southern and central Sweden (1943–45).]—*Medd. Skogsforskningsinst.* **37** no. 3, 18 pp., 8 figs., 40 refs. Stockholm, 1949. (With a Summary in German.)

The author gives a list of the known parasites of *Bupalus piniarius*, L., and notes on the frequency, habits and sometimes alternative hosts of those reared from this Geometrid during investigations in connection with an outbreak on pine in central and southern Sweden in 1943–45 [*cf. R.A.E.*, A **37** 453]. They comprised *Telenomus phalaenarum*, Nees, and *Trichogramma evanescens*, Westw., from the eggs, and *Ichneumon* (*Cratichneumon*) *nigritarius*, Grav., *I.* (*Barichneumon*) *locutor*, Thnb., *Heteropelma calcator*, Wesm., *Anomalon biguttatum*, Grav., *Euceros pruinosus*, Grav., *Blondelia* (*Lydella*) *nigripes*, Fall. (itself parasitised by *Mesochorus politus*, Grav.), and *Carcelia rutilla*, Br. & Berg., from the pupae. Up to 67 per cent. of the eggs were parasitised. The effectiveness of the larval and pupal parasites varied much from place to place, but the most important were *Blondelia*, *Heteropelma*, *Anomalon* and *Ichneumon nigritarius*, which were reared from up to 24·3, 8·8, 5·9 and 4·4 per cent. of the pupae, respectively. Dusting with DDT [*cf. loc. cit.*] reduced the parasite population less than that of the host.

Horber (E.). **Versuche zur Bekämpfung von Drahtwürmern mit Hexachlorcyclohexanprodukten.** [Experiments in controlling Wireworms with Preparations of Benzene Hexachloride.]—*Schweiz. landw. Mh.* 1948 pt. 5 repr. 4 pp., 1 fig., 5 refs. Bern-Bümpliz, 1948.

In the course of field trials of various preparations of crude BHC (benzene hexachloride) against the larvae of *Melolontha melolontha*, L., near Zürich in 1946–47 their effect on wireworms was also studied, the species concerned being chiefly *Agriotes obscurus*, L., and *A. lineatus*, L., with smaller numbers of *A. sputator*, L., and *Lacon murinus*, L. Counts of the larvae in soil samples were made by the flotation method [*cf. R.A.E.*, A **34** 329]. When the BHC was applied as a suspension in liquid manure to heavily infested grassland in September, it gave complete mortality to a depth of 10 ins. at 9 lb. per acre, but did not effect a statistically significant reduction at 2·7 lb. All wireworms were also killed by similar treatment in early May at about 16–42 lb. BHC per acre. When the BHC was mixed with calcium nitrate, broadcast in April–June at 9 lb. per acre and subsequently worked into the soil, it gave a highly significant reduction of a large population of wireworms in winter wheat and reduced a smaller population in maize. The difference in the latter case did not reach significance, but the condition of the plants was much improved. Potatoes in a field close by acquired the odour and taste of BHC, possibly owing to carriage of the dust by wind. No appreciable reduction in the numbers of larvae of *Melolontha* occurred in any of these experiments.

Papers noticed by Title only.

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CONTENTS.

CONTENTS—*cont.*

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